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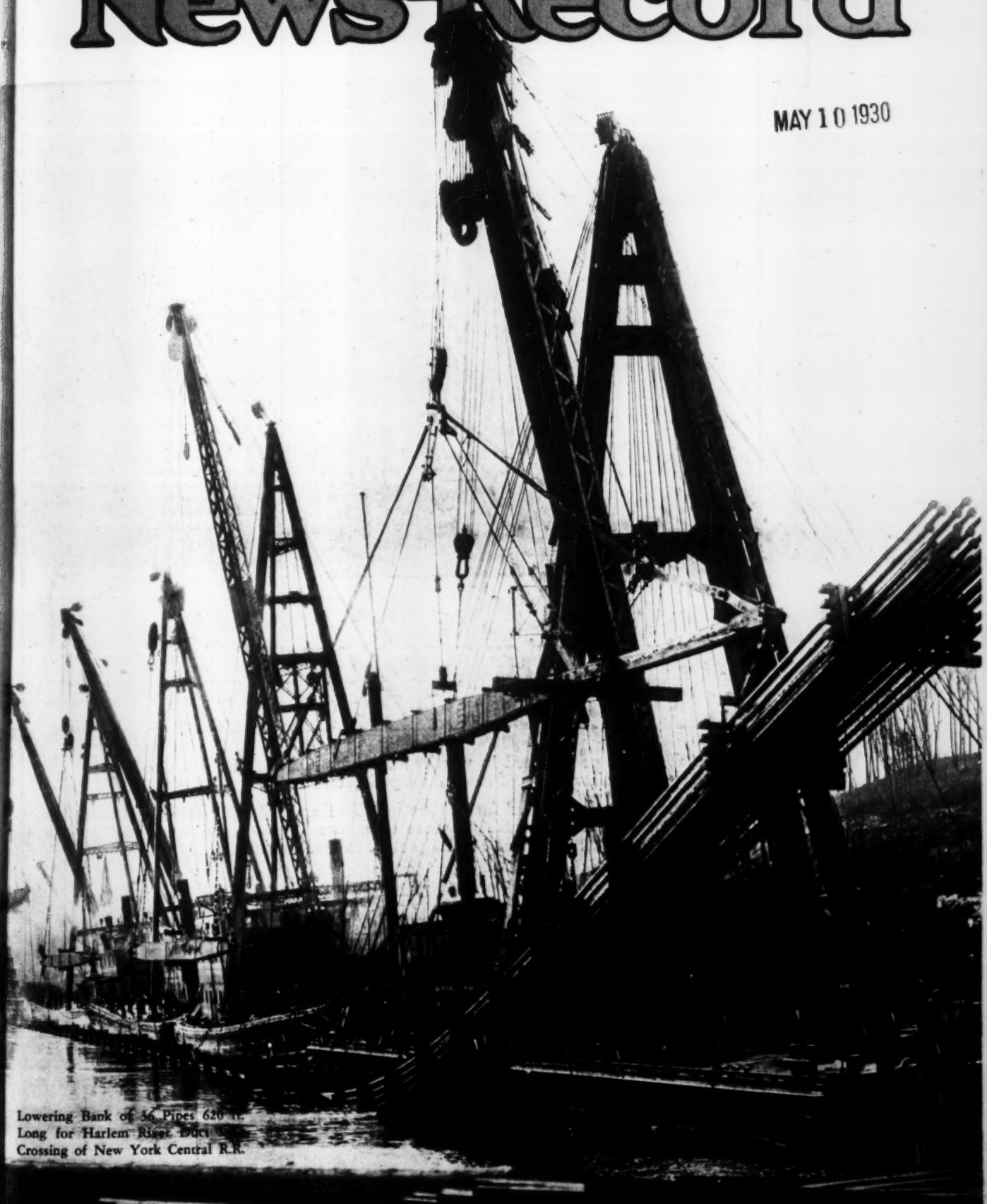

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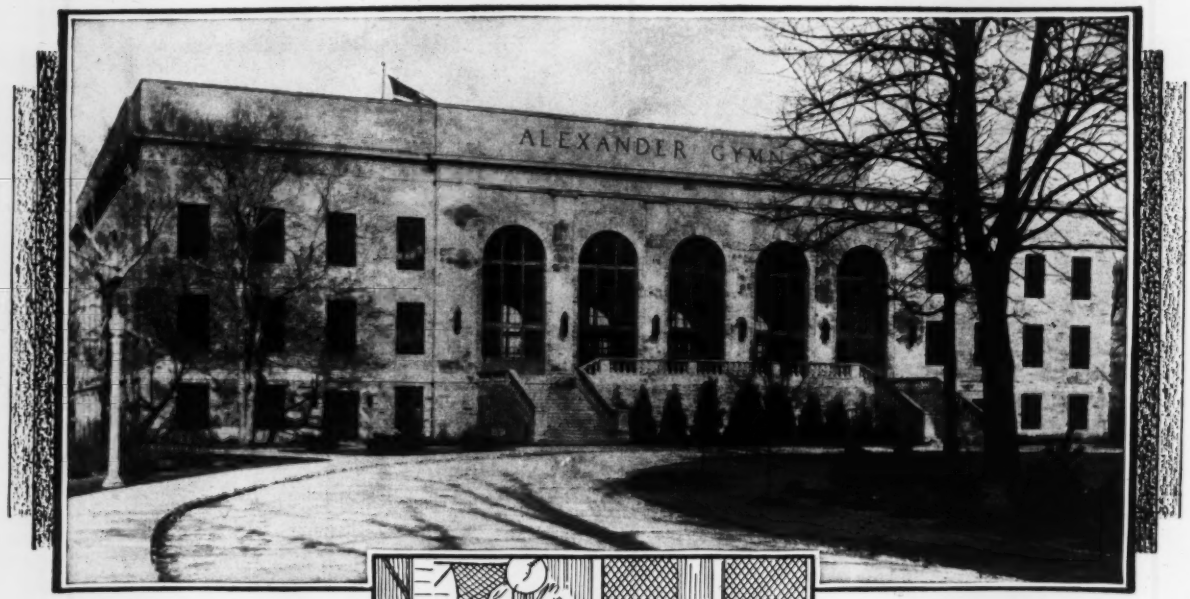

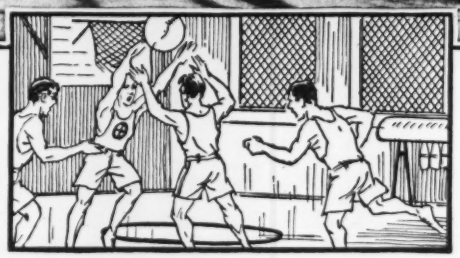

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A Consolidation of Engineering News, Engineering Record, The Sanitary Engineer, and The Contractor

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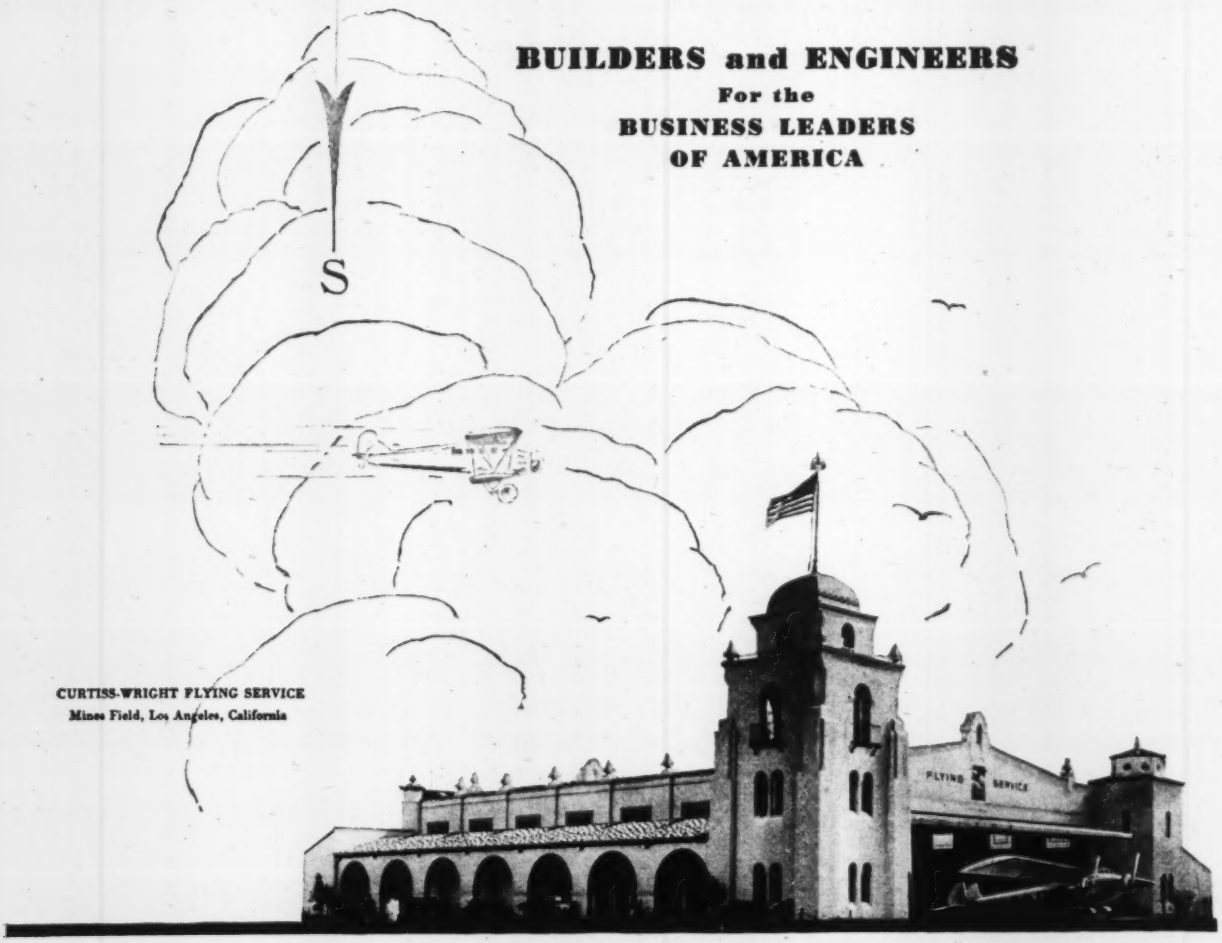

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ENGINEERING NEWS-RECORD

A McGRAW-HILL PUBLICATION — ESTABLISHED 1874

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, MAY 8, 1930 Number 19

Twenty-Five Years of Research

IT IS just about a quarter century since experimental investigation in civil engineering came to new life and the practical art began to move ahead at accelerated pace. For this reason the twenty-five year anniversary celebration of the Illinois engineering experiment station does more than mark a date in the life of the Urbana institution; it measures the march of progress in an extensive field of technical activities. The station began its work at a time when reinforced concrete was revolutionizing structural practices. Other problems of equal magnitude disturbed the working engineer then or soon after, among them slab strength, column action, the rigidity of framework; in fact, so many weighty questions arose that research was overtaxed with them—questions of railway and highway roadbed strength, arch resistance, pipe testing, fatigue of metals and many others. Experimental research grew in proportion to these demands, aided by the example of the successful work accomplished at Illinois. This institution, which remained at all times in the forefront of the work, now looks back not only to its own high achievement but also to the indirect results of its work as reflected in the remarkable growth of investigative activity throughout the country. Its present activities and strength give promise that its next quarter century will be equally fruitful.

In the News

THERE is ample food for thought in the week's news. One of the developments which has important engineering concern is the announcement that Detroit has decided to abandon its 70-year old jail, an unsafe structure housing nearly two thousand people. The Columbus horror thus appears to have produced at least one useful result, but elsewhere in the country many other non-fireproof public institutions still exist and need to be torn down. Another news happening brings a striking contrast to this survival of obsolete structures: A modern hotel in New York, the Belmont, less than 25 years old, closes its doors to make way for a new building; the demands of modernization appear to press more heavily on the private investor's purse than on the conscience of government officials. One phase of government action appears in a new and remarkable piece of federal interference in local affairs, in the shape of an order by the Interstate Commerce Commission authorizing the Long Island Railroad to abandon its Whitestone branch, claimed to be unprofitable; the railroad is wholly within one state and the traffic on the branch in question is purely suburban, for which reason the New York Transit Commission, which previously denied a similar application of the railroad for abandonment of the branch, has entered an appeal from the I.C.C. order. State rights manifest themselves more aggressively in connection with the Boulder dam project. Following on the signing of the power contract comes the charge by Arizona that this action, already three months delayed, was put through in great haste, and with the statement comes the threat to take the project into the courts. The fire toll in the Eastern states has been unusually high. In Nashua, N. H., over 100 buildings have been destroyed in a major conflagration. Brush fires, spreading rapidly because of unseasonable dryness and high winds, have damaged much property in the territory between the Virginias and Massachusetts.

Tornado Study

EXTENSIVE tornado damage in the northern Mississippi Valley last week brings a reminder of the lack of protection from this form of natural visitation. No building is designed with the specific objective of withstanding tornado action, and this is true because there is virtually no knowledge of what forces these actions may produce. Some meteorologists, as well as a few engineers, hold that the forces active in a tornado are so great that no building can be constructed to resist them. Others believe that the forces of tornadoes—at any rate of most tornadoes—are less extreme. But actual data are almost non-existent. Something in the way of study by means of an engineering survey of tornado damage was undertaken in southern Illinois a few years ago. It yielded only a few items of information, as must always be the case in such studies because of the erratic behavior of these storms and the difficulty of applying definite calculations to their destructive effects. More work of the same kind would be valuable. A systematic campaign of study, in which every tornado other than those sweeping open country would be made the subject of a quantitative survey of destructive effects, could bring together in measurable time a significant amount of information as a basis for protective design. The broadest opportunities for such study lie in the flat country of the Mississippi Valley. The engineering organizations in that region are therefore in the best position to organize such a study campaign.

Single-Track Economics

WHEN traffic on a single-track railway becomes so heavy that it is difficult to handle trains promptly or efficiently, the most obvious way of increasing traffic capacity is to provide a second track, and this is the first expedient likely to be urged by the operating officers concerned. On the other hand, it is also obvious that this second track is actually needed only during periods of traffic congestion; when traffic drops below the critical point, the large capital investment is idle and produces no return in efficiency or economy of operation. Moreover, double-tracking is a costly improvement, and if many divisions require this relief its extension may be

slow. That increased traffic capacity can be and has been secured through less expensive methods is shown by an article in another column. It is accomplished by expediting train movements on the single track by one or both of two means: first, by relocating sidings, signals, water stations and other facilities in order to reduce the time ordinarily lost during the run in waiting on sidetracks to get orders or pass trains or in taking water; second, by governing train movements by block signal indications for the entire run, instead of requiring trains to stop and report or get orders at intermediate points. While this method of increasing traffic capacity may involve relatively small expenditures, the desired result cannot be obtained without close study of the situation on an entire operating division, both as to physical conditions and traffic conditions.

Railway Traffic Studies

A SUGGESTION for the establishment of a traffic-output or traffic-production bureau is an interesting feature of the article mentioned in the preceding note. Its purpose would be the investigation of traffic capacity of railway operating divisions, in order to compare, on a uniform basis, the economy or efficiency of their operation and to determine what changes or improvements may be desirable to increase the capacity or the traffic output, considering the railroad as a manufacturer of transportation. The bureau would be independent of the regular operating staff. The proposed unit of measure is the production of gross ton-miles per train-hour, and the organization is termed, tentatively, the ton-mile production research bureau. Improvements made after an investigation of this kind in an individual case are said to have resulted in a substantial increase in this traffic output unit for the peak-load month for three or four consecutive years. It is not difficult to realize that this is possible in numerous cases, when it is considered how many divisions carry traffic far beyond the original expectations, while improvements have been of a more or less haphazard character, devised to eliminate individual troubles rather than to improve traffic operation on the division as a whole. In view of the growing demands upon the railways for improved service and the increased need for economy in providing this service, a good argument may be made for the adoption of the proposed railway traffic bureaus, which would be comparable to the production department of a manufacturing concern.

A Unique Unwatering Problem

SELDOM does an engineer or contractor have to give thought to the effect of unwatering a large excavation upon the character or condition of the groundwater at the site. Only in a few cities where the water table is high and the foundations of old buildings are shallow is concern felt for changes which the pumping may produce. But in Amsterdam, Holland, the matter of unwatering the large excavations for the new Ijmuiden lock introduced a problem which became a determining factor in a decision as to the method of construction. Construction of the locks is described elsewhere in this issue. The sand immediately underlying the site of the lock is filled with fresh water which is pumped out for domestic purposes, but at lower levels the water is brackish or salt and unfit for human consumption or industrial use. The area to be unwatered for the lock foundation was so great that unless the quantity of water to be removed could be kept down to a small minimum there was danger of upsetting the equilibrium between the fresh and brackish water. Any material change might injure the limited local supply of fresh water. In the plan finally adopted the entire site was surrounded by a deep wall of steel sheetpiling driven down into a thin layer of clay found in the sand underlying the site. This deep seal materially reduced the inflow so long as the pumping did not create an upward pressure great enough to rupture the bed of clay. Further, the fresh water pumped in unwatering the site was delivered to the provincial water-supply system in order to reduce its extraction of water from the sand by an equal amount. The scheme was ingenious; its effectiveness testifies to the value of care in advance study of delicately balanced equilibrium conditions.

Filtration for Chicago Nearer

NOW that the Supreme Court has followed its decision of the lake diversion case by a decree specifying just what is the "negligible" quantity of water that Chicago may divert from Lake Michigan and setting nine years as the time for cutting the diversion to 1,500 sec.-ft., Chicago can no longer justify delay in improving the quality of its water supply by the argument that action would embarrass the district in its legal contentions. Filtration is needed urgently, and the water-using citizen knows that it is needed. Were the water property owned by a private company, every available means would long ago have been applied to compel the company to supply clean, clear water. There would have been orders from the State Board of Health, daily publicity in the newspapers, and what not. But the municipal water service has escaped this treatment.

From an engineering standpoint the filtration project is well in hand. An experimental plant has been operating for more than two years, producing filtered water of excellent quality, which has been available for all who wish to come for it. The fact that 20,000 people do come to the plant part or all of the time shows the demand for filtered water. New things learned by the experiments are largely refinements of known methods, although the development of the chlorinated iron and lime treatment appears to have proved a most desirable method of coagulation, as has the use of activated carbon to remove tastes and odors. The experimental plant has more than justified itself. There is now no reason to delay design and construction.

Politicians should soon come to recognize that their re-election will be promoted by espousing filtration. The cost of 2c. per 1,000 gal. which filtration would impose brings the meter rate up to only 8½c. Cost has been the basic political obstacle. A difficulty of temporary nature is the dogged determination of the voters to starve out the present political régime in Chicago, which tends to make any immediate favorable vote on bonds impossible. On the legal side it is necessary to acquire riparian rights along the shore and obtain government permission to push out into the lake the pierlike structures on which the plants are to be built; but since most of the sites are in parks, these problems are not formidable.

In all respects—legal, financial, political and engineering—filtration has made progress. More publicity is needed, however, and this can be supplied only through engineers. It was fitting, therefore, that the announcement of basic data and resulting tentative plans for filtration plants should have been presented before Chicago's engineering society. The society has a civic obligation to further the cause by enthusiastic co-operation

and active promotion in the necessary publicity campaign required to bring to the contract stage this great project —by far the greatest filtration system ever proposed.

Chicago needs filtration more than it needs any other civic improvement, and Chicago can pay for it. Will her engineers help her get it?

A Monument

NEARLY 45 years ago Hermann Schussler built into the Crystal Springs dam certain things that make his structure a monument of capable engineering. After going through nearly a half century it is untouched by the tooth of time. It lived through a violent shaking in the 1906 earthquake, when the San Andreas fault, only a quarter mile away, slipped many feet. Good concrete and robust block-masonry construction are the elements that give Schussler's dam its character.

In both these matters the present-day engineer can learn from this work of the '80s, for of all the ills which beset the builder of dams none has given more concern than have deficient concrete quality and the shortcomings of monolithic construction. The latter have been attacked by reinforcement and by expansion joints superadded to care in bonding and in continuity of concrete deposition, but always with doubtful success. As to dense concrete, the resources of skilled laboratory control have been brought into play, on massive as well as on thin dams, to balance sand against stone, cement against aggregates, and water against cement, in ideal arrangement; yet what engineer will confidently say that his dam after 50 years will match the Crystal Springs dam in tightness and soundness?

Schussler's specifications, far simpler than those current today, acquire distinction through their success. And if results are the true criterion, his construction practice deserves as close imitation as modern tools and time schedules permit. It is known that he washed his stone very thoroughly, and this may be an important factor; even today the influence of dirt films on aggregates is often under suspicion, though no conclusive scientific study of the matter is on record. But good proportions, careful mixing and placing, and above all compaction by ramming, suffice to account for the dense concrete which he obtained.

Because of the widespread interest given to questions of concrete quality nowadays, this feature of the Crystal Springs practice is sure to receive full attention. The block method of construction, however, clashes so directly with present practice that it runs danger of being dismissed as an early expedient which has no bearing on modern dam construction. Such a conclusion would overlook what we believe to be the prime structural difficulty involved in the building of large dams. On this account the block-masonry character of Crystal Springs dam is the outstanding point to be considered. In its very nature it challenges the soundness of what is today universal practice in dams—namely, monolithic construction; more correctly, attempts at monolithic construction, for probably every dam of size is torn and cracked in its interior and therefore is not monolithic.

In small objects continuous concrete deposition is usually essential to the structural result. In large structures it is at best a mere convenience of construction. However desirable it might seem on theoretical and design grounds, it is fatal to its own objective because the temperature and volume changes in a large mass of concrete lead to distortions which disrupt the material. The cracks visible in the remaining segment of the St. Francis dam after the washout of the structure made this action clearly apparent, and it is now accepted beyond discussion. But aside from its practical uselessness, monolithic placing has the effect of leading to highly involved conceptions of structural actions in large gravity dams; the dam is conceived of as being a solid, continuous mass of material subject to the laws applying to an unbroken and unjointed elastic solid. When cracks form within it during construction, this conception is inevitably destroyed and the calculations become decidedly questionable. Unfortunately no one can tell what calculations should be substituted for them, since the locations and directions of the cracks are not known.

A close array of separate blocks, such as forms the Crystal Springs dam—and for that matter also the Pyramids—is of simpler nature than a continuous solid mass. It is amenable to reasonably definite calculation, which the latter is not, and it can be built as intended. Its construction can be so carried out as to make volume changes harmless and assure lasting solidity and tightness of the structure. Many stone-masonry dams attest to its effectiveness by their superior performance in comparison with concrete dams; and so also does the remarkable old structure at Crystal Springs. The latter's value to the present dam-building art, therefore, is in the example which it presents of success in block construction, and its suggestion that abandonment of attempted monolithic dam-building in favor of block building offers a way out of some of the principal difficulties now encountered.

Financial Revivification

STABILIZATION of finances and membership has made a forward step in the activities of the Associated General Contractors. With demands crowding in upon the organization for extension of its functions and with a membership which has not been too dependable in the payment of dues, there naturally followed a practice of making commitments on anticipated income, which frequently did not come up to anticipation. The result was repeated crises in the association finances, which were kept from bringing disaster only by the charitable action of the more prosperous and loyal members in "taking the association's bonds."

Obviously this was a financial policy which could not continue, and at the annual convention three months ago a new set-up of the association's business affairs was decided upon. In place of a general manager—which office has been left vacant by the lamented death of D. A. Garber—a president's cabinet was inaugurated. Aided by staff transfers and resignations amounting to $33,000 in net salary reductions, this cabinet has whipped the budget and income accounts of the association into a balance which spells present and future solvency. Pressure was exerted on the chapters and branches to cleanse their membership rolls, and a requirement was set up that new members must have submitted a past-performance report to the bureau of contract information.

As a result, today the Associated General Contractors has a solvent organization, is getting its dues with a regularity not previously obtainable, and is paying off its indebtedness to the individual members who in past years have kept the organization from the reefs of financial disaster. The association is to be congratulated on its strong financial position, and the president's cabinet and association officials are to be complimented on their constructive work in setting the organization on a safe path to more and better service to the construction industry.

Steel Design and Erection on a 900-Ft. Tower Building

Steel Frame of Manhattan Company Building in New York City Erected in 3½ Months—Fabricator in Charge of Design—Trusses Over Banking Room Carry 4,500 Tons —Special Attention Paid to Wind Design and Rigidity

By O. F. Sieder
Chief Engineer, Levering & Garrigues Co., New York City

THE Manhattan Company Building, which has recently attained height supremacy in New York City's downtown district, is an important structure in several particulars. It was erected with remarkable speed. The structural frame, involving 17,000 tons of steel, was completed between the months of June and November, 1929—partly made possible by constructing the foundations before the old buildings on the site were razed (*Engineering News-Record*, April 24, p. 691). Much of the design work was carried out simultaneously with steel erection because of the speed required by the owner. Another unusual characteristic of the job was that the steel fabricator was in charge of design, fabrication and erection, a novel and unprecedented procedure. The wind design of a structure of this type is always of major concern. On the Manhattan Company Building the design method was somewhat unique, and special systems of knee- and cross-bracing were used to supplement the more usual split-beam connections. Special framing, including a series of trusses, was necessary to provide for a large, high banking room on the first floor; also, much complicated framing was required in the apex part of the tower.

FIG. 1—THE MANHATTAN COMPANY BUILDING IN NEW YORK CITY
The tower rises some 900 ft. above the financial district. The eight tubular steel material hoistways on the west face of the building are believed to be the tallest ever used.

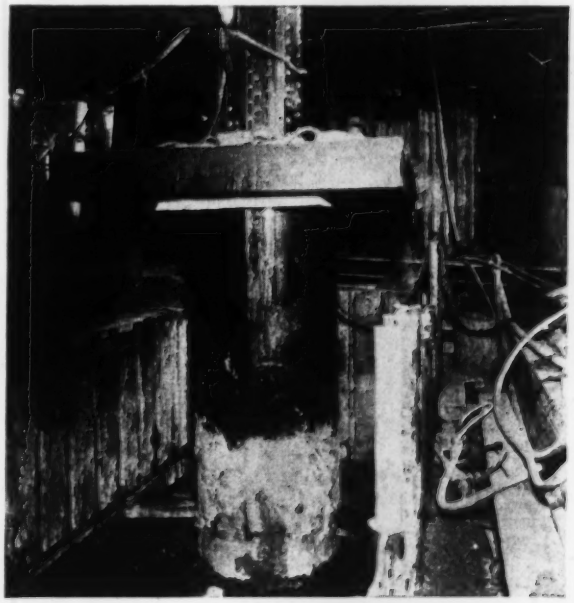


FIG. 2—A TOWER COLUMN AND ITS FOUNDATION
Foundations for the new building were sunk while old buildings on the site were being demolished. The largest of the base slabs for the new columns is 14 in. thick and approximately 7 ft. square.

Height—There are numerous ways to measure the height of a building. To the top of its flagpole, the Manhattan Company Building is 927 ft. high, although in the opinion of the writer the height of the flagpole should not be considered as a part of the building. Another way to measure height is to the topmost usable story; still another is to consider the observation platform as the top. Measured to the latter point, the Manhattan Company Building is 836 ft. Other observation platform heights are: Chrysler Building, 783 ft.; Woolworth Building, 727 ft.; Lincoln Building, 654 ft.; Metropolitan Tower, 590 ft. All of these are considerably below the Eiffel Tower in Paris, whose observation platform is located at a height of 906 ft. above the sidewalk.

Unusual Contract—In view of the large expenditure involved in the site and building, there was a natural desire to complete the structure for early occupancy. The owners, who were also the general contractors, adopted the novel expedient of intrusting the contract for engineering, fabrication and erection to a structural steel fabricator. Speed of construction became an element of the greatest importance. The requirement for speed was so compelling, in fact, that the award of the contract was made on March 20, 1929, on the basis of preliminary architectural sketch plans only. The first steel was erected on June 22. Steel up to the 60th floor was completely in place by Oct. 11. Even though wind and

weather conditions hampered erection above the 60th floor, the entire steel construction was topped out on Nov. 12.

Such unusual speed could be possible only with the most efficient sort of co-operation among owners, architects, engineers and steel contractors. On this job the steel fabricator, being charged with the design, supplemented his own engineering forces by those of a consulting engineering firm, so that the main steel design and framing plans were completed in seven weeks. Fabrication also was carried on simultaneously in three plants, the steel contractor using the entire capacity of his own plant, and in addition the resources of two plants of the Bethlehem Steel Co. This division of fabrication was absolutely necessary in order to meet the speed called for in the erection schedule.

Details of the Building—The Manhattan Company Building covers an area of approximately ¾ acre, having a south frontage along Wall St. of 150 ft., a north frontage along Pine St. of 209 ft. (part of which will be constructed as an addition to the main building) and being approximately 194 ft. deep north and south. The building covers the complete plot area up to about the sixth floor, where the setbacks begin. The tower emerges at the 36th floor with plan dimensions of 85 and 88 ft. respectively. It rises 24 stories sheer before the steelwork is drawn in to form the pyramidal roof. As shown in Fig. 3, the tower is outlined by columns 23, 28, 82 and 78. In the center of the tower area on the first floor is a banking room, 85 ft. long north and south and 33 ft. wide, entirely free of columns.

The building is served by 45 elevators, 20 of which are on the east side of the tower in three banks of eight each and one bank of six, as shown in Fig. 3. The elevator machinery for about half of the elevators is located on the 40th floor. Thirteen elevators continue to the 56th floor, while two elevators serve the penthouse floors and one goes to the observation gallery. The space occupied by the elevator shafts and corridors is approximately 100x37 ft. in the lower stories.

One of the interesting features of the project was the method used for installing the foundations (*Engineering News-Record*, April 24, p. 691). Thus, while the old buildings on the site were being demolished, work on the new foundations was under way. It was found impossible to have all the foundations completed on the date scheduled for beginning steel erection. Efforts therefore were directed to completing all of the tower column foundations, which were excavated to rock. For the other foundations, which rested on clusters of steel tubes, only a sufficient number of tubes were driven to support approximately twenty floors of steel. Then while the steel was being erected, the remainder of the foundation tubes were jacked under the large steel billets on which

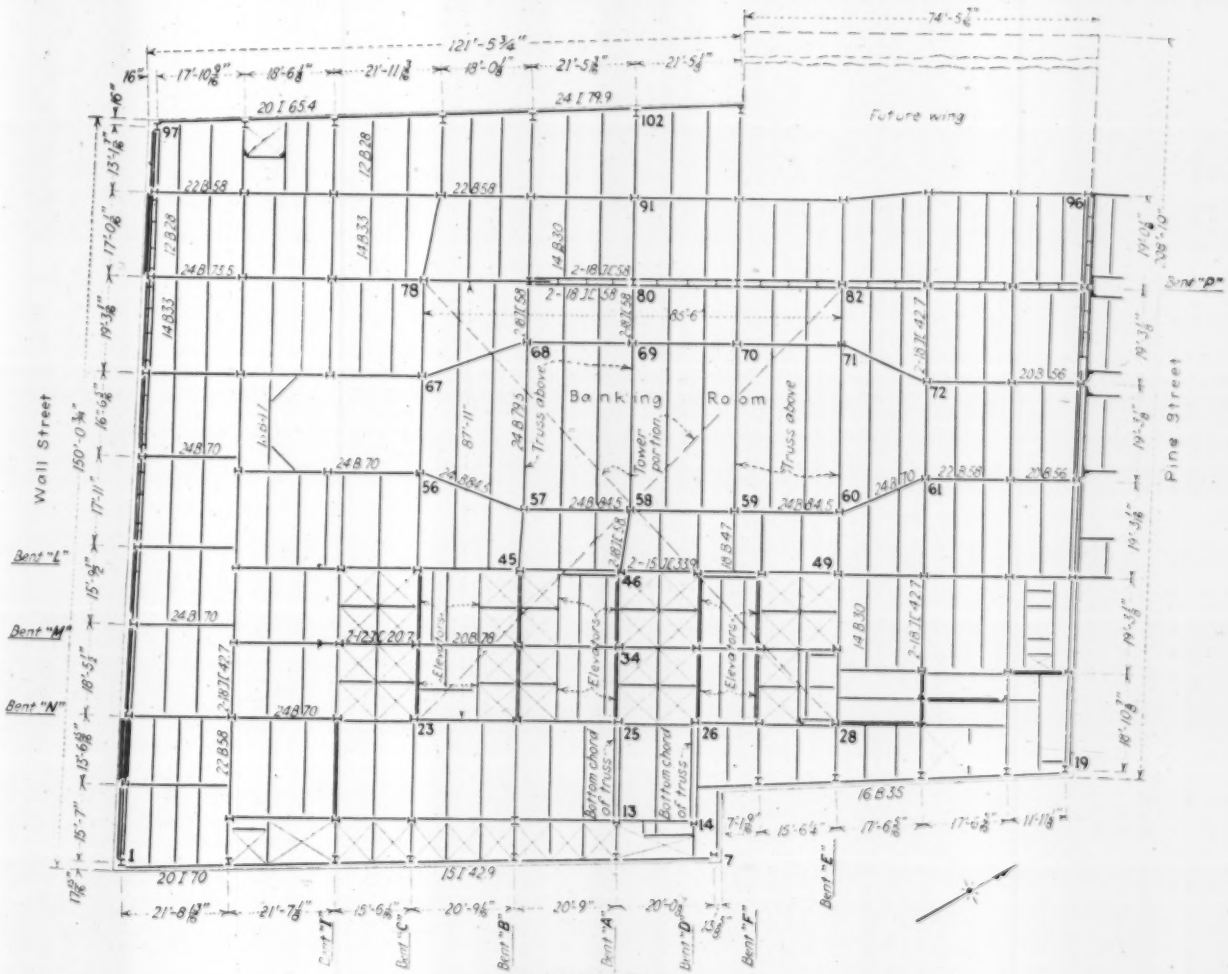


FIG. 3—TYPICAL FLOOR FRAMING, MANHATTAN COMPANY BUILDING
(*Except Banking Room*)
Wind loads distributed in wind bents as indicated. Banking room, 33x85 ft., spanned by four two-story trusses.

the columns rested. All foundations were completed before the steel reached the twentieth floor.

In general, the column make-up consisted of a rolled section and slab cover plates, although for some of the top story columns structural channels replaced the cover plates. Thus column 23, the corner column of the tower, consists of a 16-in. 427-lb. rolled section and two cover plates, 20x2⅝ in. Above the 56th floor the section of this column reduces to a 14-in. H weighing 61½ lb. and using one 15-in. 33.9-lb. channel as a cover plate. Column 46 is one of the longest columns in the structure, extending from the basement to the sixth penthouse floor, which corresponds to the 66th story. The make-up of this column varies from a 16-in. 427-lb. H with two 20x3⅞-in. cover plates in the lower stories to a 14-in. 84-lb. H at the top. The only columns which are heavier are those upon which the banking room trusses bear. Column 57, for example, is a 16-in. 427-lb. H-section with two 28x4-in. cover plates.

The largest column loads approximated 4,500,000 lb. It was found that the simplest method of distributing these loads to the foundation was by the use of slabs. It is believed that the largest slabs ever required for building construction were used on this structure, the largest being 84 in. wide, 7 ft. 10 in. long and 14 in. thick, with a weight of approximately 35,000 lb. The use of these large slabs simplified shopwork and eliminated any variability in load distribution which might have occurred if built-up grillages had been used.

One of the important factors in expediting the fabrication was the installation at the steel contractor's Dunellen (N. J.) plant of four special radial drills capable of drilling the main section of the columns and the heavy slab cover plates at the same time, a maximum thickness of metal of 7 in.

Columns were spliced approximately 1½ ft. above floor levels, with splices at every other floor. Ordinary shipping lengths therefore were about 25 ft., inasmuch as the usual story height was 11 ft. 3 in. However, some of the lower stories were as much as 16 ft. high; therefore the maximum column shipping piece on the job was 35 ft. long and weighed about 1 ton per lineal foot.

In general, spandrels are single I-beams, although in some cases these are supplemented by beams placed above and below to support special cornices. Floor panels are

FIG. 5—TOPPING-OUT THE TOWER OF THE MANHATTAN COMPANY BUILDING

26th floor setback was utilized as a transfer platform, the guy derrick lifting steel from the street while other derricks above, raised it from the 26th floor to the floor being erected. The other derricks shown are stone derricks, although the one boomed out at the top lifted the light steelwork. The creeper derrick may be seen standing above the extreme top of the steelwork. Wall St. is in the lower foreground.

approximately 20 ft. square. Girders in the lower stories consist of wide-flange sections which are 18 in. to 22 in. in depth, while the filling-in beams, framing generally in a east-west direction approximately 7 ft. on centers, are wide-flange sections which are 14 to 16 in. deep. All steelwork is flush, dropping approximately 5 in. below the finished floor, which consists of cinder and concrete arches.

Banking Room—The most difficult framing in the structure resulted from the provision of a banking room on the first floor, 33 ft. wide and 85 ft. long, free from

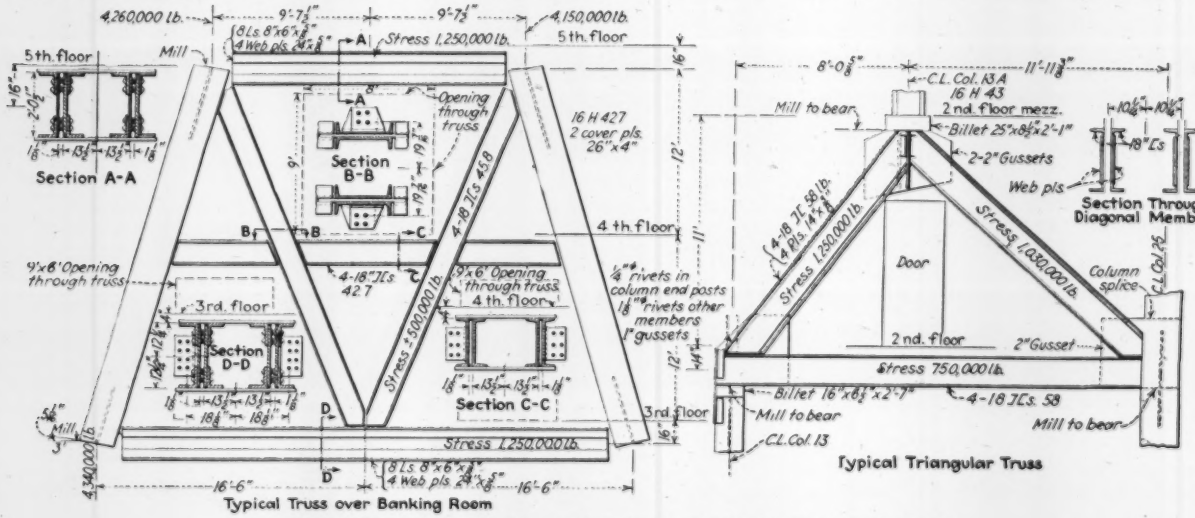


FIG. 4—DETAILS OF TRUSSES, MANHATTAN COMPANY BUILDING

4,500,000-lb. load carried through end post of banking room trusses.

columns. Not only were the design and fabrication of the trusses over this banking room a structural problem of major proportions but transferring wind loads through them proved a governing factor in the design.

As indicated in Fig. 3, there are four of these trusses, situated between the third and fifth floor levels with a span of 33 ft. east and west. The column loads brought to these trusses from above are carried directly through the inclined end posts to columns below. The size of these end posts therefore must be large in order to be stressed to 4½ million pounds. Their make-up is the same as that of the columns. The web members of these trusses were so arranged that three corridor openings through them were possible, two on the third floor and one on the fourth. The top and bottom chords of the trusses are built-up box sections of four webs and eight angles. Other members are of similar construction, except that the angles and web plates are replaced by structural channels.

Longitudinal bracing between the trusses on the fourth and fifth floors consists of 12-in. I-beams for the three interior connections and two 18-in. channels back to back for the portal connections. These channels are connected to the end posts of the trusses by means of split I-beams, the flanges of which are riveted to the end posts, while the webs slip between the backs of the channels.

The columns which rest on top of these trusses are entered between gusset plates shop-riveted to the end posts, these plates being 54x1x6 ft. 4 in. The gusset plates joining the supporting columns, the bottom of the end posts and the bottom chords are shop-riveted to the columns. The end posts, approximately 25 ft. long, are fabricated in one piece. The connecting columns and both ends of the end posts are milled on a bevel. Horizontal crossbracing consisting of 12-in. 20.7-lb. channels shown in Fig. 7 is used between the trusses in the plane of the third floor.

Two smaller triangular trusses are located just east of the elevator shafts between the second and second mezzanine floors. On both of these the single column load is carried eccentrically, so that one member of the truss carries about 25 per cent more of the load than the other, the maximum in any one truss member being 1,250,000 lb.

Wind Design—The windbracing in a tall building is necessarily the most important feature in the structural design. For purposes of determining panel wind loads the designer recognized that wind velocity becomes greater in direct proportion to the distance above the ground, partly because the lower portions of the building are shielded by neighboring structures. He therefore assumed a pressure of 30 lb. per square foot at the top and 20 lb. per square foot in the structural frame from the 60th floor down to the eighth floor, omitting wind pressure from the eighth floor down. The stresses from wind moments and shears calculated by the use of this assumption were all well within the limits imposed by the building code. Special efforts were exerted to keep the total deflection under wind within reasonable limits. Rigidity was considered to be of prime importance, and distortion in beams and columns from wind, distortion in connections and deformation of columns under axial wind loads were carefully investigated, to the end that the maximum allowable stresses under wind alone, or under combined live load and wind loads, should not exceed 20,000 lb. per square inch.

Owing to the various offsets in the lower floors of the building, the columns outside of the tower area were not of sufficient section to carry wind stresses without being considerably increased above the sections required for dead and live loads only. For this reason the service portions of the building, especially the elevator shafts, were

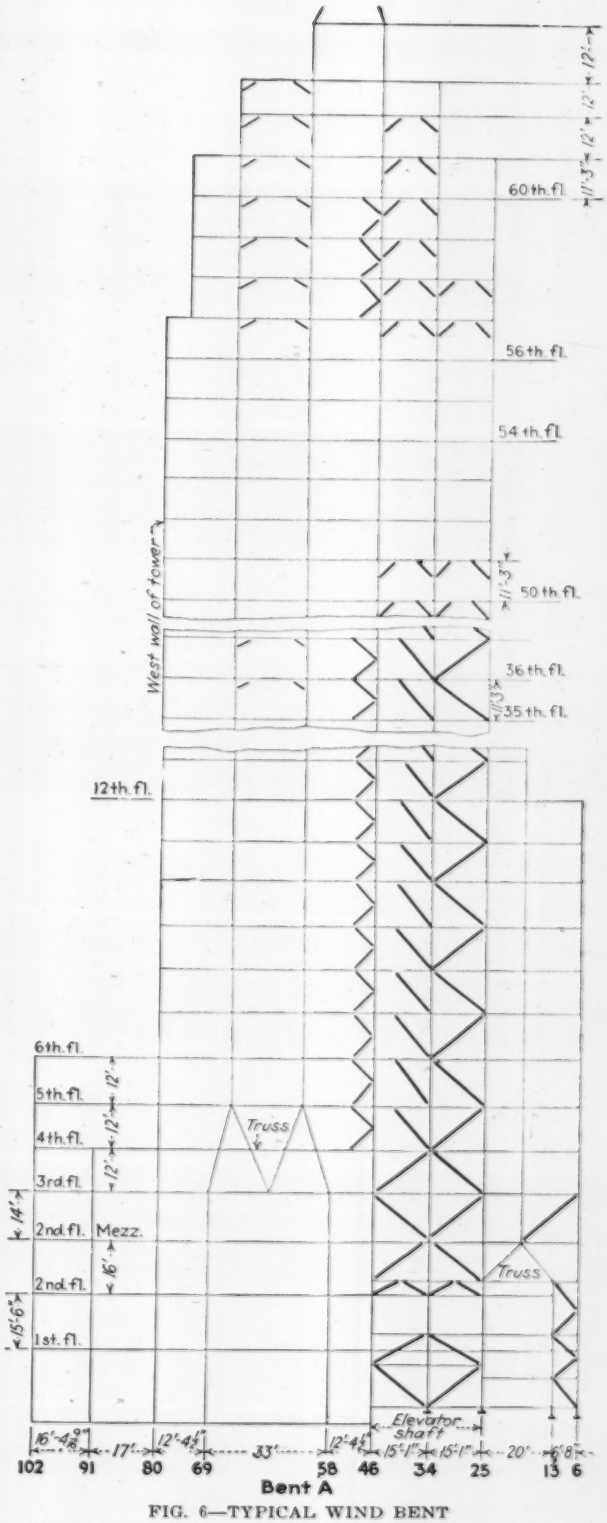


FIG. 6—TYPICAL WIND BENT
Wind connections of flame-cut I-beams in panels where kneebraces were not possible

utilized for installing substantial crossbracing. Where complete crossbracing interfered with architectural considerations in the outside walls, kneebraces were employed. All other wind connections were split beams.

The wind bents in which the loads are distributed are indicated in Fig. 3. In an east-west direction all five column lines in the tower function as wind bents. In the north-south direction, only four column lines can be used, inasmuch as the two others are discontinuous because of the banking room trusses. The wind loads are distributed among the bents so that all will have approximately the same chord deflections, causing the building to act as a unit.

Considerable horizontal bracing is necessary in the third floor, in the bays on either side of the banking room, to transfer the wind loads brought to the trusses to wind bent columns. For example, columns 48 and 50 are connected to column 60 by two 15-in. 33.9-lb. channels. Similar bracing connects column 80 to columns 68 and 70. Also on the third floor there is a complete set of horizontal bracing between the trusses. This is typically shown in Fig. 7, where 12-in. 20.7-lb. channels serve as the crossbracing members. Typical wind connections are also shown in Fig. 7.

Erection—The speed with which the erection had to be completed offered many erection problems. Owing to the height of the building, the steel was raised to the upper levels in two lifts, one lift taking the steel up to the 26th floor and the other raising it to where it was required above the 26th floor. Five guy derricks were used for the lower portion of the building, one derrick of 50-ton capacity being placed on the Wall St. side to receive the heavy columns for the tower portion. One similar heavy derrick was placed in the center of the tower to erect these columns and heavy trusses. The three other derricks were 15-ton capacity equipment. All five derricks were carried to the thirteenth floor, after which the heavy derricks were removed and four standard derricks were in use thereafter up to the tower base, where the derricks were rearranged, one being left on the offset to hoist from the street to the 26th floor and two derricks

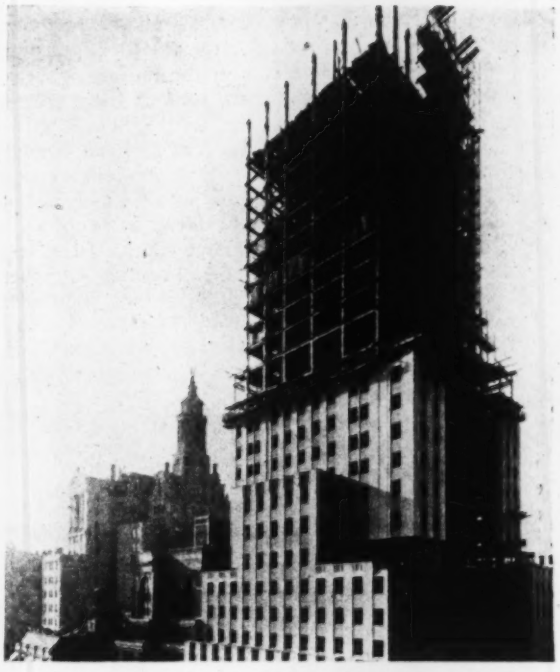


FIG. 8—RIGIDITY SECURED BY KNEEBRACES, PINE ST. FACE
Note steel for connection of new addition. This is now completed.

going into the tower section receiving their steel from the 26th floor. These derricks were carried up to the 60th floor, where one was removed and the other relocated and used up to the sixth penthouse floor.

From this point up a creeper was used consisting of a derrick boom with jib attached near the center. The portion of the boom below the jib extended vertically down into the steel already erected and was secured to the building just below the jib and at the bottom. Before removing the guy derrick from sixth penthouse floor, a stiff-leg derrick was erected on the fourth penthouse

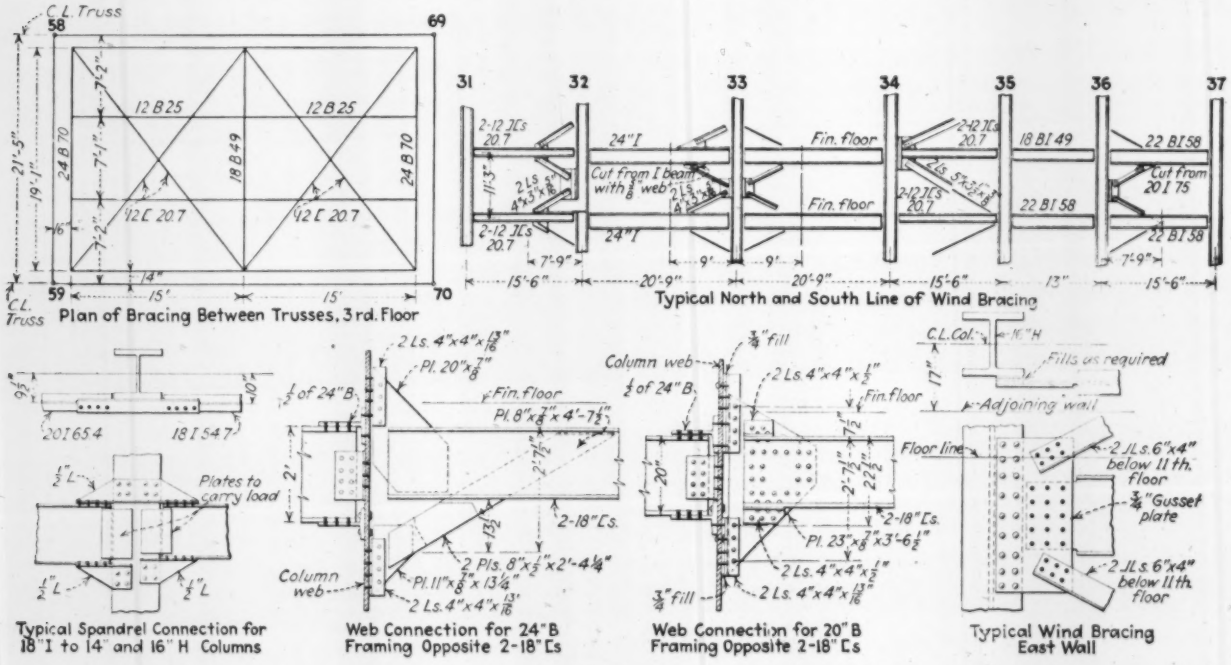

Plan of Bracing Between Trusses, 3rd. Floor
Typical North and South Line of Wind Bracing
Typical Spandrel Connection for 18"I to 14" and 16" H Columns
Web Connection for 24"B Framing Opposite 2-18"Cs
Web Connection for 20"B Framing Opposite 2-18"Cs
Typical Wind Bracing East Wall

FIG. 7—TYPICAL WINDBRACING AND CONNECTIONS, MANHATTAN COMPANY BUILDING

floor principally for use in setting stone, but it was also used to hoist, from the 26th floor offset, the last few stories of steel and the pinnacle. This pinnacle was 27 ft. high and was fabricated, shipped and erected in one piece. The use of the stiff-leg derrick made it unnecessary to make any long hoists with the creeper jib. The framing used in topping out the tower was complicated. None of the pieces to be erected in the upper portion of the tower was heavy and the winds which blew consistently at this high elevation made erection very difficult. Extreme care, therefore, was used for this part of the work and was entirely justified, since no serious accident occurred. In fact, there were no serious accidents and no lives were lost during any part of the work on this building.

The building is owned by the 40 Wall Street Corporation. The Starrett Brothers Corporation is the general contractor. The Levering & Garrigues Co. held the contract for design, fabrication and erection of the structural steel. The firm of Purdy & Henderson was consulting engineer on the design. H. Craig Severance was the architect and Yasuo Matsui and Morrell Smith were associate architects.

Progress on Sydney Harbor Bridge

About Half of the 28 Panels in the 1,650-Ft. Steel Arch Are in Place—Cantilever Erection Without Falsework

ERECTION of the 1,650-ft. steel arch highway and railway bridge over the harbor at Sydney, Australia, has progressed until eight panels of steel are in place on the south side and about four panels on the north side. There are fourteen panels in each half of the arch. End bearings for the arch were placed early in 1928, and to date approximately half of the 37,000 tons of steel required is in place. This is exclusive of the approaches, both of which are practically complete. Work on the Dawes Point (Sydney) or south cantilever has been suspended until eight panels of steel in North Sydney arm are in place, after which the arms will be built out simultaneously to the center.

Erection of the arch is being accomplished by cantilevering from each end, an elaborate system of hold-back cables being attached to the top chords. Except for a short section of bottom chord in the first panel, no falsework has been used. There are 128 anchoring ropes, each approximately $2\frac{3}{4}$ in. in diameter. The top chord attachment for these ropes consists of a box member of five triangular plates, as shown in Fig. 4. The pull of the ropes is transmitted to this top chord connection by means of eight transverse pins 11 in. in diameter, passing through the triangular plates. Individual ropes are attached to sockets held by pairs of bolts, the rear ends of which engage equalizer bearings on the transverse pins. The triangular plate assembly in turn is connected to the top chord by two 27-in. diameter pins.

Tunnel anchorages are used, 120 ft. deep and inclined at approximately 45 deg. A cross-tunnel is situated at the base of the inclined tunnels and the anchorage ropes are continuous from one top chord to the other, having a length of about 1,200 ft. A view of the rope entering one of these anchorage tunnels is shown in Fig. 5.

Two special erection travelers have been built to operate on the top chords of the arch. These travelers, which may be seen in several of the accompanying illustrations, carry a crane with a lateral movement of

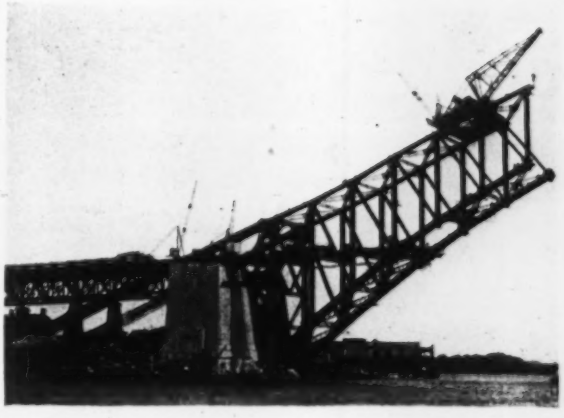


FIG. 1—THE SOUTH OR DAWES POINT END OF THE SYDNEY HARBOR BRIDGE
Note hold-back ropes leading from top chord down to anchorage. Main boom of erection traveler is mounted on a transverse track and serves both trusses.

$118\frac{1}{2}$ ft., sufficient to serve both arch trusses, which are $98\frac{1}{2}$ ft. center to center. The boom of this traversing crane carries a main falls of 120-ton capacity (at 40-ft. radius) and a set of auxiliary 20-ton falls dropping from a trolley carriage riding on the lower chord of the main crane boom. On the rear of the traveler are mounted two $2\frac{1}{2}$-ton cranes for general utility service. The travelers are moved up and down the arch by means of link-chain winches which are mounted on the extreme end of each top chord. The design of these travelers was considered in detail in an article in *Engineering News-Record*, April 5, 1928, p. 538, describing the early stages of construction work on the bridge.

Special erection procedure was necessary for the bottom chord in the first panel above the hinge pin. This was such a massive member that it was erected in six pieces, being split in half lengthwise and in thirds cross-

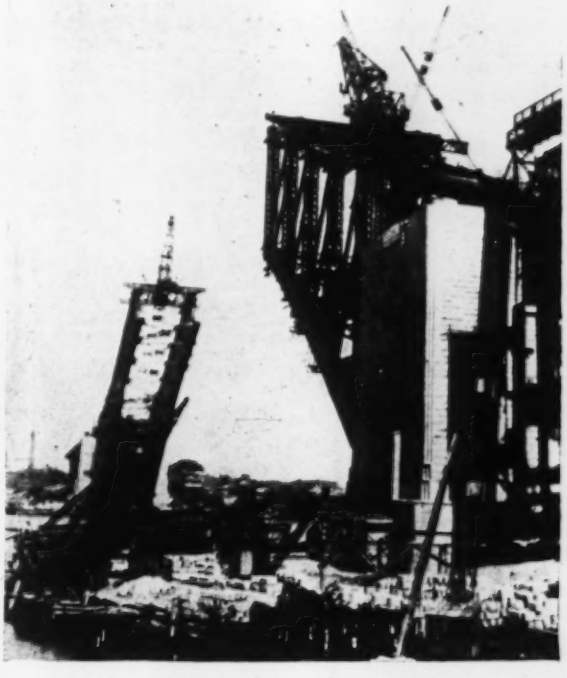


FIG. 2—SYDNEY HARBOR BRIDGE LOOKING SOUTH
Progress to middle of March shown.

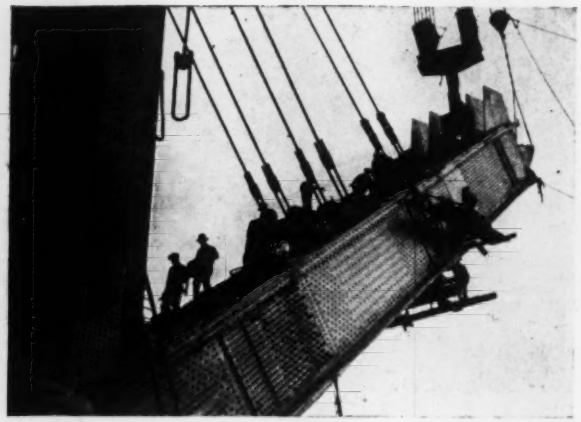


FIG. 3—ERECTING FIRST PANEL OF LOWER CHORD

wise. The lengths of the three crosswise sections are evident from the splice plates shown in Fig. 3. A temporary falsework bent was placed beneath the outer end of the first section, but the remaining sections were erected by anchoring them to the vertical post by means of tension rods until the first diagonal member could be erected. The end post had previously been anchored by a set of eight cables and a raking strut which tied it back to the pier pylon. After completion of the first panel steelwork and the attachment of the main anchorage of 128 cables, the end post anchorage cables were removed. The raking struts were still in position when the photograph shown in Fig. 1 was taken. They may he identified as the inclined members connecting the top chord with the top of the pier.

It is planned that closure of the arch will be effected by slackening the anchorage cables, permitting the two ends of the arch to come together on a special locking pin; horizontally placed hydraulic jacks will provide the additional lengthwise movement that is necessary. When closure is complete, the travelers will be at the center of the arch. As they move backward toward the abutments, they will place the hangers and the deck steel.

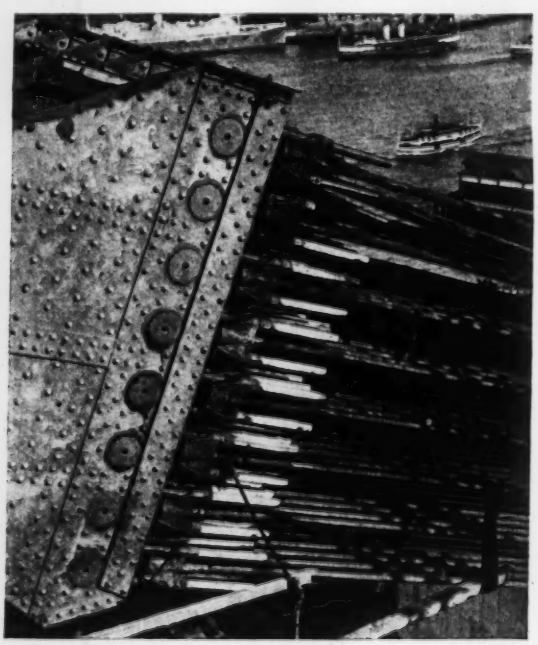


FIG. 4—ATTACHMENT OF HOLD-BACK CABLES TO TOP CHORD

Each of the 128 cables is socketed, and the sockets held by means of two bolts attached to equalizers bearings on the 11-in. diameter pins whose ends can be seen.

FIG. 5—HOLD-BACK CABLES ENTERING ANCHORAGE TUNNEL

The tunnel is U-shaped so that cables are continuous from one top chord to the other.

No estimate as to when the bridge will be in service is available. Since its beginning the work has been interrupted by labor troubles, seventeen strikes having occurred up to the latter part of November. On the other hand, when work has been under way rapid progress has been made. It is reported that the best day's erection tonnage, from daylight to dark, has been 530. The work is being done by Dorman, Long & Co., Middlesborough, England.

Sewage-Disposal Plant at Construction Camp

Sewage and waste water from the 400-man camp occupied during construction of the Salt Springs rockfill dam being built by the Pacific Gas & Electric Co. on the Mokelumne River in California is put through a sewage-disposal plant before being returned to the river. The collecting system consists of 8-in. wood-stave pipe lines from the various buildings which deliver the sewage by gravity flow to the disposal plant, located about a mile downstream from the camp. The raw sewage first enters a large timber tank made by lining an excavation 150 ft. long, 50 ft. wide and 10 ft. deep which had been dug with power shovels. This tank is equipped with baffles, and the retention period is long enough to approximate septic tank action. The effluent is piped to a small dosing tank which discharges intermittently through filters onto a bed of crushed rock. Discharge from this trickling filter runs onto a bed of fine sand on the bank of the river and filters slowly through into the streambed. Fresh layers of sand are added when necessary to maintain the efficiency of this last filter. The system operates entirely by gravity and has proved very effective for handling the sewage. The plant layout was made by the construction department of the Pacific Gas & Electric Co.

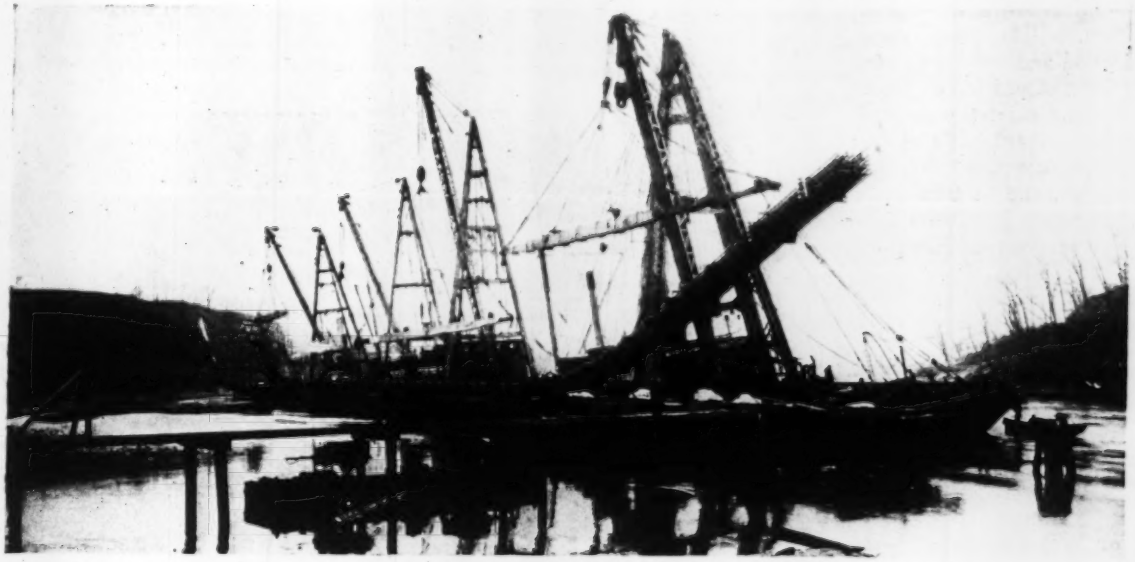


Fig. 1—Four Floating Derricks Acting in Unison Handling Bank of 36 Conduit Pipes 620 Ft. Long for Harlem River Crossing

Bank of 36 Conduit Pipes 620 Ft. Long Laid Across Harlem River as One Unit

Four Floating Derricks Acting in Unison Lower N.Y.C.R.R. Power Duct Lines Assembled on Dock to River Bottom Trench—Varying Length Hanger Lines Bend Pipes to Desired Curvature in Lifting

A SUBMARINE pipe installation of unusual character and scope was made on Sunday, March 2, 1930, when a duct line of 36 conduit pipes 620 ft. long, accurately curved up at the ends to conform to the riverbank contour, was placed in one piece and one operation in a prepared trench under the Harlem Ship Canal, 35 ft. below low water, near Spuyten Duyvil, New York City.

This was accomplished by the use of four of the largest floating derricks of the contractor's fleet, the "Monarch," "Capitol," "Colossus" and "Century," secured end to end as one unit, piloted by a flotilla of launches and tugs, accurately guided into position by mooring wires anchored up and down stream and maneuvered to a position crosswise of the stream; then the duct bank was lowered into its trench, conforming accurately to its resting place.

The assembly consists of twenty-eight 4-in. extra-heavy wrought-iron pipes and eight 3½-in. pipes of the same material, arranged in four horizontal and nine vertical rows, held by 58 wooden collars spaced 10 ft. apart. It was made up on a temporary assembly dock near the shore of the river, and provides a 620-ft. power line crossing for the New York Central Railroad's West Side electrification development.

The reason for constructing this type of crossing was primarily to secure a permanent facility for carrying power, signaling and communication wires under the river by means that would be free from the disadvantages of the ordinary type of cable crossing. The pipes have been placed deep enough to be permanently below any possible future dredging line that may be adopted for the Harlem River. This type of duct line is probably immune to the danger of dragging anchors. Sufficient spare ducts have been installed to take care of any possible future power requirements.

The 36 pipes were assembled in a horizontal plane, tested, painted, and then bent to the desired curvature as a part of the lifting process by an ingenious arrangement of varying length pennants and lifting gear.

Throughout the entire job particular attention was given to preserving the pipe coating and to laying a perfect line, true to contour. Every detail and move was carefully planned, and prior to the final group operations detailed printed instructions were given to all foremen, operators and fleet captains, clearly defining their stations and duties from the time they reported with their respective outfits or equipment to the time the entire fleet was disbanded. The job was completed exactly as planned in all respects, without a hitch or accident of any kind.

Assembling the Pipes and General Preparation—Details of the lifting and assembly collars or frames are shown in Fig. 3. Specifications required assembly frames to be placed 10 ft. on centers; for the straight section of pipes, each fourth or fifth of these frames was reinforced and developed as a lifting point; for the curved ends, however, lifting bales independent of the assembly frames and pivoted on a fixed shaft were assembled with the pipe.

A temporary assembly dock, 625 ft. long, was built along the shore adjacent to the crossing location.

The pipes were assembled, connected with screw couplings, acetylene-welded completely around each end of the coupling, and coated with two coats of priming and two coats of bituminous enamel and tested with air at

90 lb. while in a horizontal position. The pipes were assembled and welded to one side, then placed in separator frames and painted, one pipe at a time. As the life of the pipes is dependent on the enamel and the oil on the inside of pipes, great care had to be exercised to insure a perfect coating, free from cracks. At the points where the separators were in contact with the pipes, wood veneer was fastened over the pipe by wire to protect the enamel and to assist the slipping of the separators on the pipe in bending. There was considerable discussion as to whether the pipes would bend without a sharp bend or kink and whether the enamel would crack. A thorough inspection showed a perfect job in both respects. During the extreme cold weather the pipes were covered with canvas and heated to prevent possible damage to the enamel. This precaution was also resorted to for several hours prior to bending the curves at the ends.

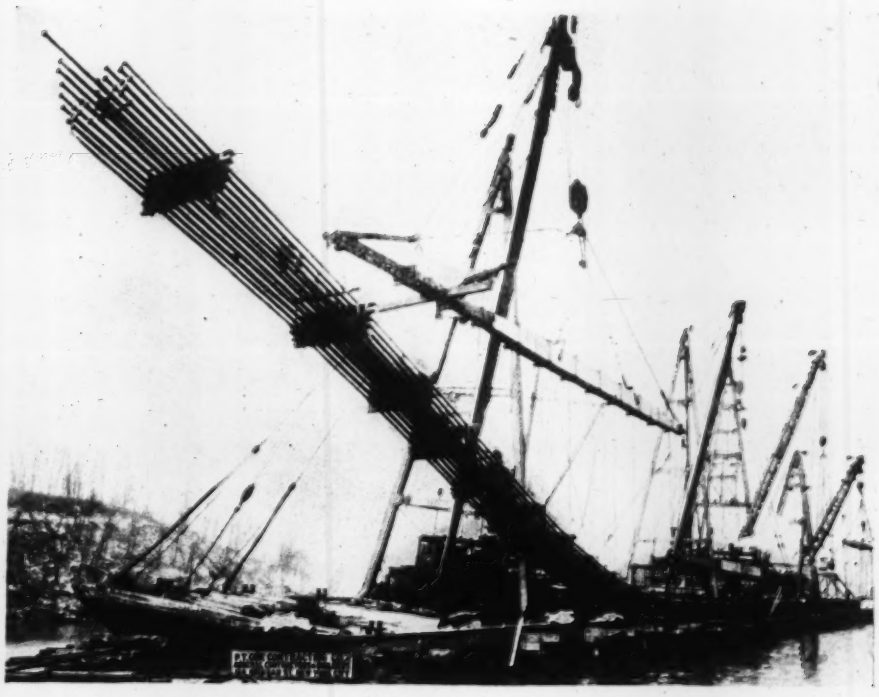


FIG. 2—BENDING ONE END OF PIPE ASSEMBLY
Pennant lines hanging from spreader boom of end derrick adjusted to give pipes proper curvature as they are lifted from dock.

The dredging was done with a dipper dredge, which made a uniform and smooth bottom. The material excavated was fairly stiff clay. Near the south shore some rock had to be removed to reach the desired grade.

Lifting Gear—Fig. 3 shows details of the lifting and bending arrangements. Each derrick was provided with a horizontal boom, acting as a spreader frame, to which pennants or hangers carrying the assembly were fastened. The horizontal spreader booms were 95 ft. and 100 ft. long on the two center derricks, and were 100 ft. long with a 20-ft. extension on the "Century," and 100 ft. long with a 30-ft. extension on the "Monarch," the end derricks. The extensions were trussed at the connecting points, as can be seen in Fig. 2.

The spreader booms were carried by the main fall of the derrick booms, through a system of matched pennants and equalizers, and were controlled in alignment by the side falls. From these spreader booms, wire pennants of the correct length to form the contour of the pipe-line were connected to special bridles on the bank assembly. Fig. 3 shows this assembly.

Original designs called for circular curves at each end to a radius of 240 ft., and this feature provided many

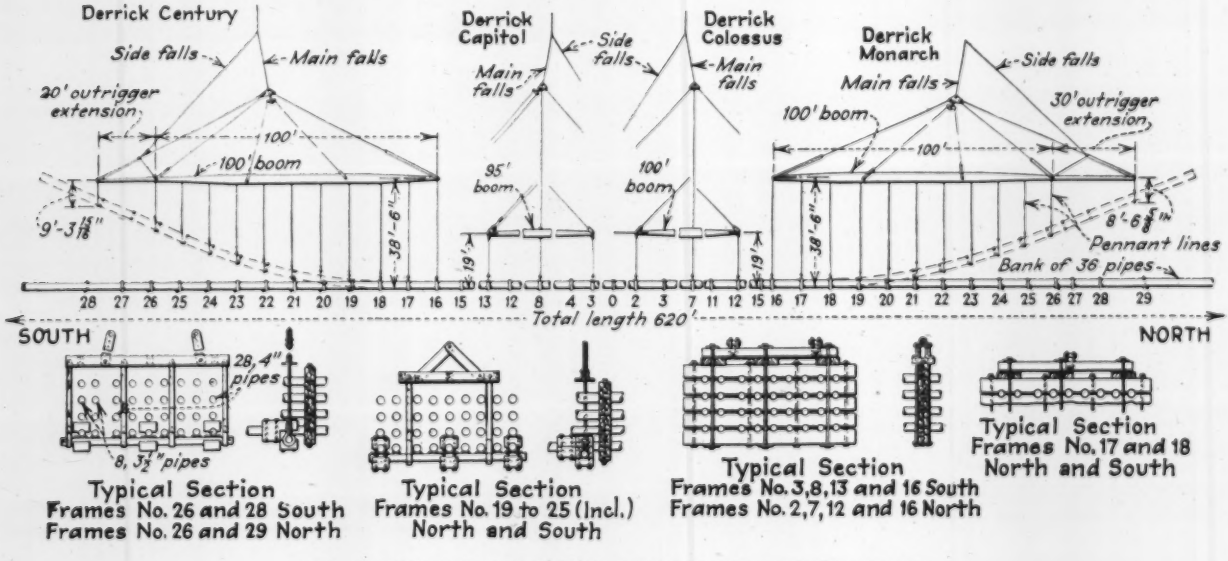


FIG. 3—DETAILS OF DERRICK RIGGING AND LIFTING GEAR

problems. Thorough studies made as to the methods of bending and assembly showed that bending of individual pipe lengths would be costly, cumbersome in assembly and doubtful as to true radii without short kinks or tangents at the ends of each pipe length; it was therefore decided to assemble the pipe horizontally and bend the entire assembly as a unit. Tests were then made and devices designed and developed for handling this operation. In bending, however, it was deemed advisable to abandon the specified circular curve, which would require a complicated system of weighting, with the risk of kinking or snapping at the tangent point, and substitute therefor a parabolic curve, based on flexure formulas, computed very carefully, as a beam supported at the tangent point, and pennants provided to control accurately this curve and insure perfect tangents; the maximum variation from the circular curve was but 8 or 10 in.

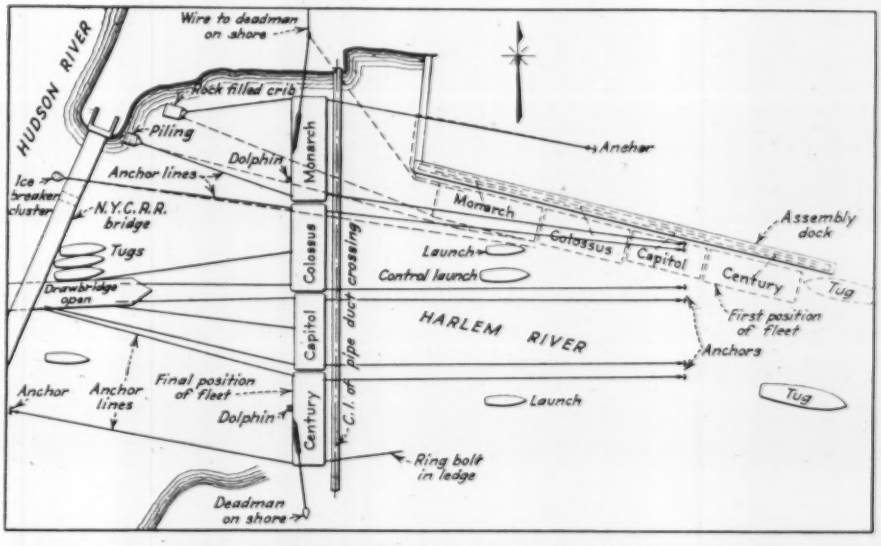


FIG. 4—MAP OF SITE, SHOWING ORIGINAL AND FINAL POSITION OF DERRICK FLEET

The pennant lines of the end derrick lifting gear were so adjusted that, as the lifting booms were hoisted to a horizontal position, the pipes would bend to the desired curvature. In starting the lift on the end section, the short pennant lines on the extreme end took up first, starting the bending at the pipe ends. As the hoisting continued, each succeeding pennant took up, bending the pipes gradually. After the bending was completed, all four derricks, lashed together and acting in unison, lifted the entire bank of pipes off the dock, and were maneuvered out into the stream in position for lowering the ducts into the trench previously dredged across the river bottom.

FIG. 5—DUCT LINE ASSEMBLY READY FOR LOWERING TO RIVER BOTTOM

Maneuvering the Fleet and Lowering the Pipes—Fig. 4 shows the arrangement of the derrick fleet and its position at the start and finish of the moving. Maneuvering of the fleet was done by means of the mooring lines shown.

The first move was to clear the dock, and then the duct line unit was lowered until the horizontal section was submerged, which lightened the load on the derricks. The fleet then was worked around to position over the pipe trench, the "Monarch" end going to the north side of the river. After the fleet was in final position, the lowering was commenced, controlled by a signal system of large numbered cards, whistles and flags from a control launch. The lowering was done by 12-in. stages, all derricks slacking off simultaneously, the horizontal alignment being checked by gages on each derrick. As the curved end sections were submerged the center of gravity of these sections shifted, requiring careful handling of the booms of the end derricks to prevent any undesired bending or buckling in the pipes.

Particular precaution and careful judgment were necessary at all times to cope with strong and varying tide conditions peculiar to this locality, heavy wind which developed during the maneuvers and rocky shoals encountered on the south shore.

The derrick fleet was assembled, anchors were placed and the pipes bent and lifted clear of the dock on Saturday. Final maneuvering was started Sunday morning at 6 o'clock, the pipe was in final position about noon and at dusk the entire fleet was disbanded.

Personnel—The work was done for the New York Central Railroad under the direction of F. B. Freeman, chief engineer. The P. T. Cox Contracting Co., New York, had the general contract for the entire work, which includes subsurface duct lines north and south of the pipe crossing. The river-crossing work described here was done by the Merritt-Chapman & Scott Corp., as subcontractor, with George Burrows, assistant construction manager, in charge, assisted by George Tooker, superintendent of the derrick department, in direct command of hoisting operations and fleet maneuvers, and A. Siecke, engineer, who designed and co-ordinated the various gear and equipment for handling.

40-Year-Old Concrete in Crystal Springs Dam Still Watertight

Proper Construction Methods Made a Durable and Impervious Structure With Material Far Below Present-Day Standards

By F. R. McMillan and M. B. Lagaard
Director of Research and Associate Engineer, Portland Cement Association, Chicago

AN ENDURING monument to careful construction methods is the Crystal Springs dam, about 20 miles south of San Francisco, built in 1887-90 as a part of the system supplying that city with water. Not only has this dam been in service 40 years without showing any bad effects from exposure or from hydrostatic pressure but it passed through the San Francisco earthquake of 1906 without damage, although situated only ¼ mile from the fault line on which the earthquake movement occurred. This dam stands today as the equal of some of the best concrete structures of modern times, despite the fact that it was built long before modern methods of insuring good construction had been developed. At this time, when so much study is being given to factors affecting the durability of engineering work, a structure with such a record of performance, even though in a relatively mild climate, warrants attention.

Accordingly, in connection with a nationwide survey of concrete structures, the writers made a careful inspection of the present condition of this dam. It was apparent from almost the first glance that the remarkable quality is not accidental but that definite factors are responsible for the excellence of this work.

The general correctness of the formwork alignment, the good condition of the joints and the freedom from the usual construction defects are outstanding features. Although the peculiar plan of construction, which involved interlocking blocks, was a construction novelty, the feature of particular interest now is the hard and durable quality of the concrete, occurring not only in localized spots but as the general, uniform condition throughout the structure. This homogeneity of the structure must have been obtained by recognizing correct principles for the construction of the project and by adhering rigidly thereto.

Fortunately, the records of construction on this dam are unusually complete. This in itself is significant, since it indicates an interest on the part of those responsible for the work which was more than a desire merely to complete the job. Many data about the construction are recorded in a book entitled "Water Supply of San Francisco, Calif., Before, During and After the Earthquake on April 18, 1906, and Subsequent Conflagration," by Hermann Schussler, then chief engineer of the Spring Valley Water Co., who designed and built the dam. A copy of this book and several illustrations used in this article were made available to the writers through the courtesy of George A. Elliott, vice-president and chief engineer of the Spring Valley Water Co. The following extract from Mr. Schussler's book outlines the standards that governed construction on the Crystal Springs dam:

> One barrel of A-1 portland cement, 2 bbl. of clean, sharp sand, and about ⅔ bbl. of water, thoroughly mixed with 22 cu.ft. of hard, clean, washed rock, broken into sharp-edged fragments of all sizes (the largest pieces to go through a 2½-in. ring). This amount of material with the proper workmanship makes fully 22 cu.ft. of first-class concrete in place.
>
> The broken rock before being put into the mixer to be thoroughly washed in order to make a perfect bond with the mortar and saturated with clean water, . . . the wetting being to prevent the absorption of any part of the water contained in the mortar, which water is essential for properly completing the chemical process of hardening the cement mortar.
>
> The concrete after being thoroughly mixed is to be transported at once to and put into its place in the work under construction within fifteen minutes after mixing. Here it is to be rapidly spread in layers not exceeding 3 in. in thickness and to be thoroughly rammed by hand until the new layer is completely consolidated with the former one and all the interstices between the rock fragments are completely filled by the cement mortar.
>
> The next day's work is to make a close, tight junction with the work of the previous day.
>
> New work is not to be exposed to the sun, but kept covered with planks and sprinkled with water until completely hardened.
>
> In the construction of the Crystal Springs concrete dam and all our other concrete work, the above proportions and methods were strictly adhered to; only in the Crystal Springs dam (being of very massive dimensions) the alternate block system was adopted. . . .
>
> That the above-described method of carefully selecting the materials for all our concrete, and employing the very best care and workmanship in the execution of the same, was the proper method is shown not only in the most perfect condition (after the earthquake) of the concrete foundations of all our pumping plants, but also and particularly by the fine condition of the concrete at San Andres reservoir and the Crystal Springs concrete dam, the former being practically on the fault, while the latter was located less than one-third of a mile northeast of the same.
>
> Concrete made of a poorer quality of material or of a poorer mixture or made with less care or with inferior workmanship would have succumbed in the terrific strain put on the same by the earthquake, especially in the neighborhood of or on the fault line.

The specifications are significant in the light of concrete practice today. Perhaps the first item that will attract the attention of the engineer is the large proportion of coarse aggregate represented by the 1:2:5½ mix. Such a mixture would be impossible of placement without segregation or honeycombing under the usual methods of handling now in vogue. One of the construction views on this work (not reproduced) shows fourteen or fifteen men engaged in tamping the concrete in one of the individual blocks while only five wheelbarrows are seen bringing concrete to the block. This indicates the extreme care that must have been taken to consolidate the dry, harsh concrete.

Another feature of these specifications is the amount of water—two-thirds of a barrel per barrel of cement. Perhaps this was not in anticipation of the water-cement ratio as now used, but only a means to secure in the dry mixture the uniformity which it was desired to obtain. It is worth noting, however, that the use of this cement

CLOSE-UP OF UPSTREAM FACE AT SOUTH END
Well-defined form marks indicate excellent state of preservation of surface.

Concrete Construction 40 Years Ago—Crystal Springs Dam in California

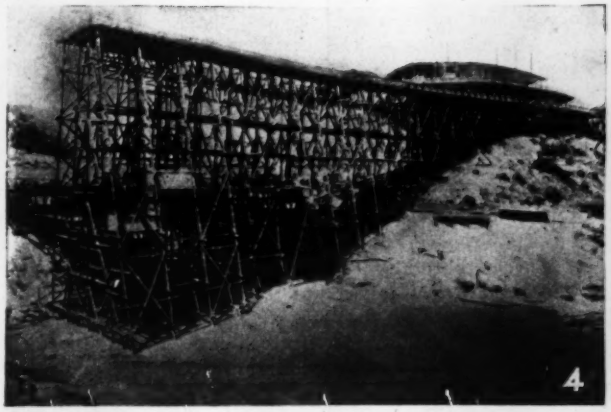
1. TOP AND DOWNSTREAM FACE IN 1908
View looking northwest. Note block construction. The present roadway occupies the full dam width.

2. CONSTRUCTION VIEW—WETTING DOWN FINISHED CONCRETE
Plank covering was used to permit pressure hosing and to shield fresh concrete from the sun's rays.

3. TOP OF THE DAM, SHOWING RECESSED BLOCKS
The surface was left rough in anticipation of a future addition to height.

4. CONSTRUCTION VIEW OF CONCRETE PLANT AND TRESTLE
Note large accumulation of material discharged from washing plant. In left corner is portion of dam.

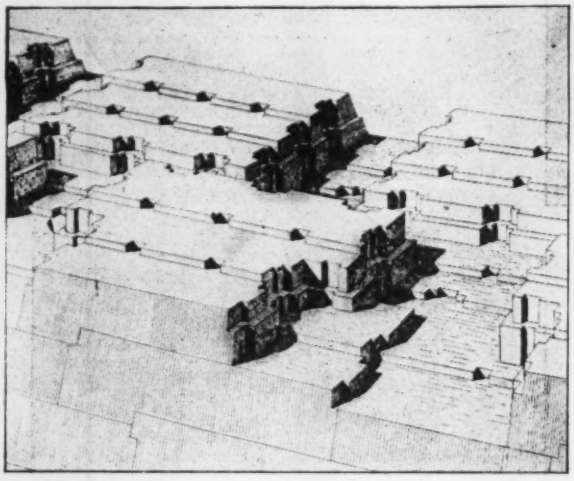
5. VIEW OF CONSTRUCTION CREW CLEANING SURFACES
Note the recesses and offsets for interlocking the blocks.



paste of low water ratio (about 5 gal. per sack of cement) is one of the factors which accounts for the resistance to water penetration and the perfect preservation of the structure through its long period of service.

The thorough ramming in thin layers until, to quote the designer, "the new layer is completely consolidated with the former one and all the interstices between rock fragments are completely filled with the cement mortar," insured that all the space between the aggregate particles was filled with this cement-water paste, so that the watertightness of the paste itself actually determined the watertightness of the concrete.

The provision for protecting the surface from the sun and sprinkling with water "until completely hardened"



REPRODUCTION FROM ORIGINAL DRAWING SHOWING IN PERSPECTIVE, ALTERNATE BLOCK SYSTEM FOR PLACING CONCRETE

undoubtedly had an important part in providing the quality that made this structure so successful.

The contract for the purchase of cement for this dam, written longhand under date of May 30, 1887, contains the following, relative to the quality of the cement:

> Portland cement is to be ground to such a degree of fineness that when passed through a sieve having 2,500 meshes to the square inch of surface there shall be a residue not to exceed 10 per cent by weight of the amount originally placed on the sieve . . . Portland cement to be of such strength that when molded neat in briquets and immersed in water within 24 hours shall not after seven days' immersion break under an average tensile strain of 350 lb. per square inch of section.

The contrast between the simple requirements for this cement and the present-day tendency to high strength and fineness is most interesting. The experience with this structure shows that with proper water content, careful placing and thorough curing, durable concrete can be obtained with a cement which would rate far below today's standard, a fact which stresses the value of careful construction methods.

That very little water ever found its way through this structure is evidenced by the extremely small deposits of calcium carbonates to be seen along the horizontal joints on the downstream face. Pictures taken successively in 1897, 1904 and 1908, by their similarity confirm the observation in this regard and prove that such seepage as there was at fill planes occurred only in the early life of the structure and has remained unchanged for many years. By far the greater proportion of the construction joints on the downstream face show that a perfect seal was secured.

On the upstream face the surface of the concrete is free from spalling, cracking or other signs of disintegration. The original board marks are still plainly visible and there is a notable uniformity of the concrete in the different layers.

In conclusion, a study of this dam does not suggest that a return to the dry mixes and laborious methods of hand tamping is necessarily to be advocated. The point is, rather, that the complete filling of the space between the aggregate particles with a cement paste of low water-cement ratio achieved by this method accounts in large measure for the excellent performance. The same result can be accomplished by plastic mixtures at much less labor cost and with greater certainty, provided the plasticity is obtained by reducing the quantity of aggregate for a given quantity of cement and not by adding water.

The use of a mechanical vibrator, which is a comparatively recent innovation, shows considerable promise of providing a partial return to the stiffer consistencies without the disadvantages of increased labor cost or uncertainty of complete consolidation.

Besides complete consolidation, the two factors of greatest importance in extending the useful life of the Crystal Springs dam were the use of clean, sound aggregate and careful provisions for thorough curing. In reference to these factors, also, the present-day constructors are at no disadvantage provided the importance of these considerations is recognized and provision is made accordingly.

Gasoline Taxes Collected in 1929 by All States

Reports received by the U. S. Bureau of Public Roads show that the 48 states and the District of Columbia collected $431,636,454 in taxes on the sale of 13,400,180,062 gal. of motor fuel in 1929. This includes collections for only five months in Illinois and eight months in New York, the last state to adopt this tax. The average fee per gallon was 3.22c., as against 3c. in 1928. In the course of the year 20 states increased the rate of taxation either 1c. or 2c. The highest tax per gallon was 6c.; the lowest 2c. At the close of the year three states had a 6c. tax, eight a 5c. tax, nineteen a 4c. tax, one (Utah) a 3½c. tax, ten a 3c. tax, and seven states and the District of Columbia a 2c. tax.

Comparison of the total number of vehicles registered in 1929 with the total tax collected and with the taxable gallonage in all states (except New York and Illinois) and in the District of Columbia shows an average tax revenue of $17.72 per vehicle and an average purchase of 532 gal. of gasoline. After deducting collection costs, the entire net revenue in 34 states was used for construction and maintenance of rural roads. In the fourteen remaining states and the District of Columbia a total of $24,405,207 was used for other purposes. In three states part of the tax money helped support public schools. In eight states a part of the revenue went to cities for repair and improvement of streets, as did the entire collection for the District of Columbia. In six states small sums were deposited in general funds; in Mississippi a special extra tax was collected in two counties for seawall protection of highways, and in New Jersey a small fraction of the receipts was turned over to the Department of Commerce and Navigation. Of the revenue applied to rural roads, $297,967,756 was used for construction and maintenance of state highways; $85,113,708 for construction and maintenance of local roads; and the remainder, $23,371,785, applied as payments on state and county road bonds.

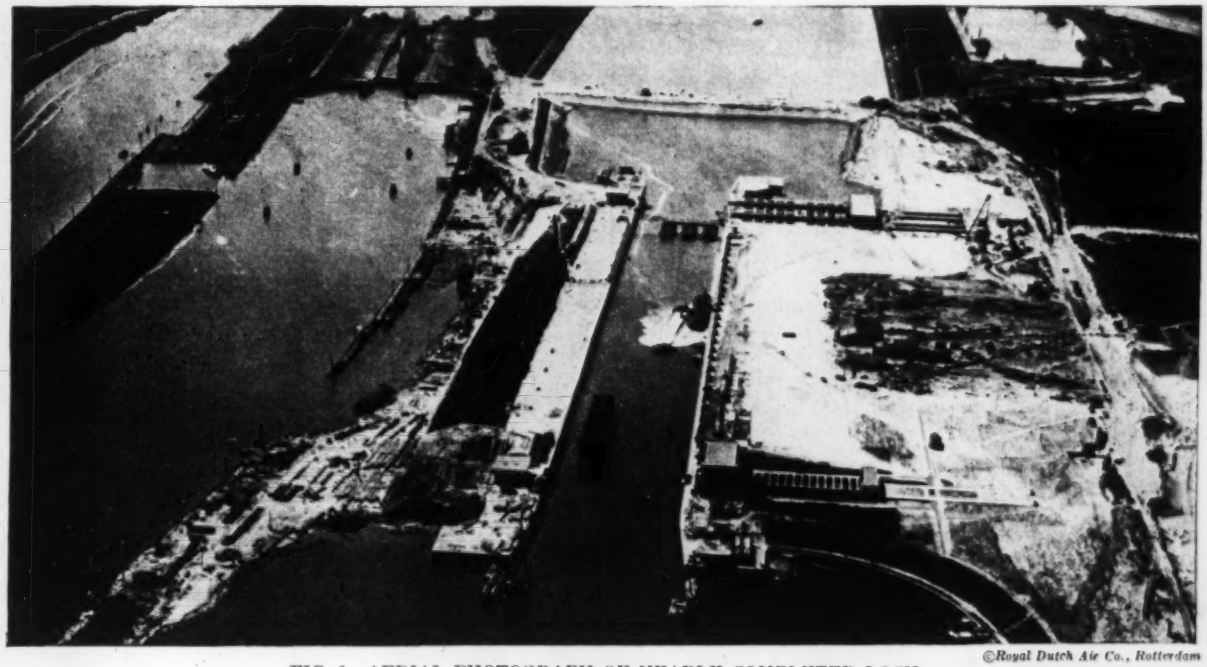


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FIG. 1—AERIAL PHOTOGRAPH OF NEARLY COMPLETED LOCK

Construction of the New Ijmuiden Lock

Rolling-Caisson Type Gates Installed in New Entrance to North Sea Canal—Groundwater Condition Presents Unusual Problem

By J. A. Ringers
Chief Engineer of the Rijkswaterstaat, Wieringen, Holland

AMSTERDAM, the capital of the Netherlands, 650 years old, has come to be one of the most important ports of commerce in the world. Up to the beginning of the nineteenth century the harbor of the city was approached by way of the shallow Zuiderzee. At that time a canal 78½ km. long was built connecting the harbor with the sea, accommodating ships of 17-ft. draft. In 1876 the considerably shorter North Sea canal was opened for traffic, reducing the distance from the city of Amsterdam to the mouth of the canal, called "mouth of the Ij," or Ijmuiden, to 23 km. The Ijmuiden locks built at the time offered passage to vessels having a maximum draft of 25 ft. As ship sizes continued to increase it was necessary to enlarge the lock in 1896 so that it was 225 m. long and 25 m. wide, with a depth of water at the sill of 10 m. Finally, in 1924, construction was started on a third lock. When completed, this new lock will be 400 m. long (1,315 ft.), 50 m. wide (161 ft.) and will have a depth of water over the sill of 15 m. (about 50 ft.) at the average stage of the tide. The canal itself, between Amsterdam and the new lock, now has a bottom width of 50 m. and a depth of 10 m. It is to be widened immediately to 75 m. and deepened to 12½ m., and as soon as navigation developments demand, it will be further enlarged to correspond with the size of the new lock.

The gates for the new lock are of the rolling-caisson type. Under ordinary conditions only one gate will be necessary at each end, but an additional gate has been placed at the outer end of the lock, as shown in Fig. 3, to provide for emergencies. The recesses into which these caissons roll can be transformed into dry docks by placing bulkheads across their entrances. When so transformed they can be dewatered in five hours, so that repairs or replacements can be made within 24 hours.

The three caissons are identical in construction and size, and are therefore interchangeable. Each gate has the double purpose of retaining the water in the canal when the sea level is lower than the canal level, and excluding the sea water when the sea level is higher than the canal level. Each caisson is 53½ m., or 175 ft., long, 20.3 m., or 66 ft. 6 in., high, and 7.3 m., or 24 ft., wide. They were fabricated lying flat in a shipyard at Rotterdam, were launched as a ship and towed 64 km. over the North Sea to the site of the new lock. When they had arrived at this location they were turned over to an upright position by allowing water to enter two of the air chambers (Fig. 5).

The magnitude of the lock, especially its great depth, brought about many problems which were quite difficult to solve. The lock is situated in the dunes (sandhills) which protect lower Holland from the North Sea. These dunes have an average height of 8 m. above sea level, with occasional summits extending as high as 30 m. With excavation extending down to an elevation of 20 m., therefore, a total cut of from 28 to 50 m. was necessary. The total quantity of excavation amounted to nearly 20,000,000 cu.m. (about 25,000,000 cu.yd.), extending over a length of 3½ km. Most of this excavation has been accomplished by the use of bucket excavators; during the last two years, however, steam shovels and draglines have come into use. In the outer channel

suction and bucket dredges will be employed. All the spoil so far has been loaded into barges and transported to Amsterdam to be used there in filling up the low marshes of the surrounding district.

The greatest difficulty was occasioned by the fact that the supply of fresh water for the district is obtained from the fine water-bearing sand underlying the dunes. In the neighborhood of the lock this water is used on a large scale for both domestic and industrial uses. The construction of the lock brought up the possibility of two very dangerous developments: first, that the output of this supply would be reduced; second, that there would be an increase in the chlorine content of the water, rendering it unfit for use. The fresh water in the sand, collected during centuries of rainfall, lies over the salt water at a depth of from 100 to 130 m. below sea level. This salt water streams under the dunes to the polders, the drained marshes below sea level. There is in existence a state of equilibrium between the fresh and salt water, the destruction of which would allow the salt water to rise. The construction of a deep pit, such as the Ijmuiden lock would require, is quite likely to disturb such a state of equilibrium. Beneath the excavation something like a volcano of salt water would be found, with a resulting intermixture of the salt water and the fresh water lying on the slopes of such a volcano. This reasoning has been based upon numerous hydrological observations in the Dutch dune regions.

Such a development could be avoided, of course, if compressed air could be used during the construction of the foundation. The Dutch law governing the use of this method for such purposes, however, is rather exacting, so that the cost of such a method of construction would prove to be prohibitive. In order to determine whether a dry pit could be constructed, a new set of borings was made, some of them extending to the depth of 130 m., to determine the character of the material underlying the proposed lock foundation. In general the subsurface material at this point is sand, but in addition three layers of clay are encountered: one at a depth of about 18 m. below sea level, which is observed over the whole area, a second at about 40 m. and a third at about 100 m. below sea level. The water used for household and industrial purposes is drawn from between the first and third layers (see Fig. 6).

The water pressure at the depth of the first layer of clay was found to be that equal to a head of about 18 m. It became possible, therefore, to excavate an open pit to a depth of 9 m. below sea level and still maintain a state of equilibrium between the burden of the sand above the layer of clay and the pressure of the water beneath it. In order to isolate such a pit from the surrounding

FIG. 2—MAP OF NORTH HOLLAND
Showing location of North Sea Canal and Ijmuiden.

water-bearing sand, it was decided to inclose it with steel sheetpiling driven into the middle clay layer. Such a system of construction, however, would require piles 30 m. long, and the maximum length that could be obtained was 26 m. It was decided therefore to excavate the pit 4 ft. deeper than had originally been intended, allowing the steel sheetpiling to have its top at an elevation of —13 m. In order to decrease the hydraulic pressure on the under side of the top layer of clay to compensate for the deeper excavation, wells were sunk before excavation was begun, with strainers at elevations ranging from —22 m. to —32 m. Fresh water was pumped out of these wells until the pressure beneath the top layer of clay was decreased to that corresponding to a head of about 9 m. of water. This pressure would be just balanced by the weight of the earth lying between the top of the upper clay layer and the bottom of the excavation, as the specific weight of the sand was nearly 2. The decreased water pressure was maintained by pumping from 70 to 80 cu.m. per second. Pumpage at that rate meant, of course, that during the period of construction of the lock, estimated to be four years, nearly 9,000,000 cu.m. of water would be removed. To prevent the loss of such a quantity of water, it was forced through a long pipe line to the provincial water-supply station about 4 km. away, where it was given the

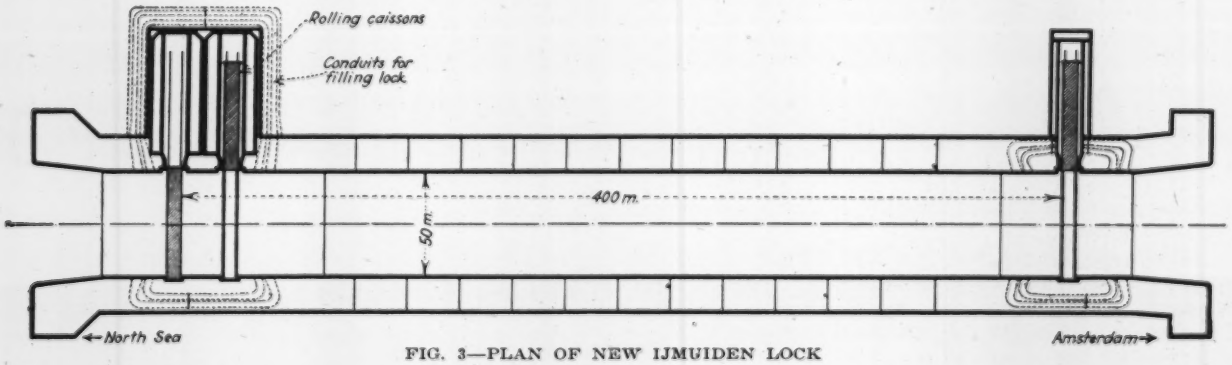


FIG. 3—PLAN OF NEW IJMUIDEN LOCK

necessary treatment and then distributed to the consumers.

The sheetpiling, weighing 155 kg. per square meter, was driven in pairs, each pair weighing some 3,000 kg. The driving was assisted by the use of a water jet, but the last 2 m. of penetration was accomplished by the use of a 4,000-kg. steam hammer. These last 2 m. required from 1,500 to 2,000 blows. Piledriving proceeded at the rate of about 27 ft. run per day per driver.

On account of the heavy cost involved, deep foundations were provided for only the two ends of the lock. The walls of the chamber proper are supported by a foundation slab 16.7 m. wide and 1 m. thick, with the bottom at elevation —7½ m., in turn supported by numerous concrete piles. In front, the earth is prevented from slipping by concrete sheetpiling with a thickness of 0.53 m.

Lock chambers are filled, as a rule, by means of longitudinal conduits built in the side walls, from which the water is allowed to discharge through a number of openings distributed over the entire length of the lock. After a long study in the experimental and hydraulic station at Charlottenburg, Germany, under the direction of the late Prof. H. Krey, it was learned that such methods of filling are not necessary. The ideal condition to be obtained is one in which the lock can be filled with a minimum of strain being placed upon ships' hawsers.

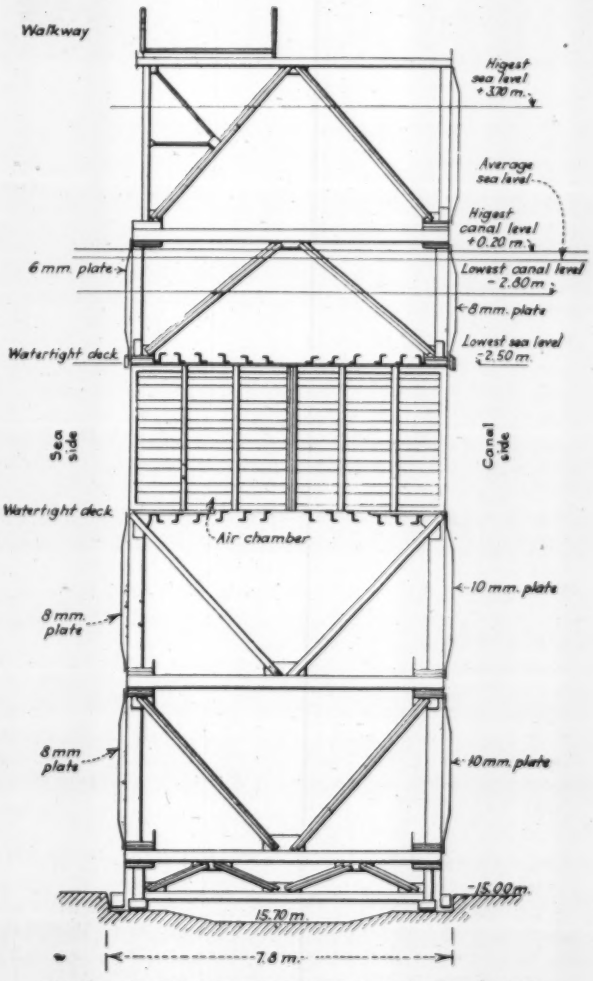


FIG. 4—SECTION THROUGH CAISSON-TYPE GATE

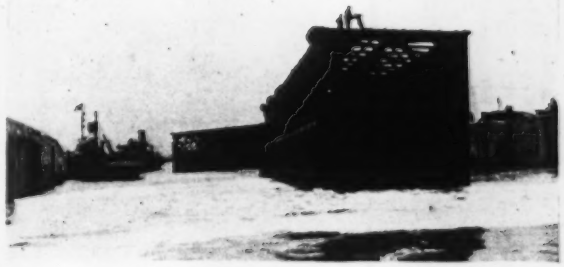


FIG. 5—GATE FLOATING IN UPRIGHT POSITION

It was found that this condition could be obtained by building conduits in the ends of the lock only, if the following conditions were met:

1. The opening of the valves in the conduit must be done slowly. (In the Ijmuiden lock the raising of the valve stems will take 9 minutes and 30 seconds in order to fill the lock chamber in 12 minutes when operating under a head of water of 4 m.)

2. The conduit should be of rectangular cross-section but with the bottom beveled sharply in the vicinity of the valves. These arrangements have the purpose of giving a small discharge while the head of water is great.

3. To decrease still further the velocity of discharge, the conduit should be tapered between the valves and the outlets. (At Ijmuiden the area at the outlet is 2½ times that at the valves.)

4. The axis of the conduit should be curved so as to direct the discharge water against the lock gates. The flowing water impinges against the gates and is reflected back into the chamber so that it is dispersed over the entire area.

Such good results were obtained from the experiments that the Dutch government opened an experimental hydraulic station of its own at Delft, in the building of the Dutch Technical Academy.

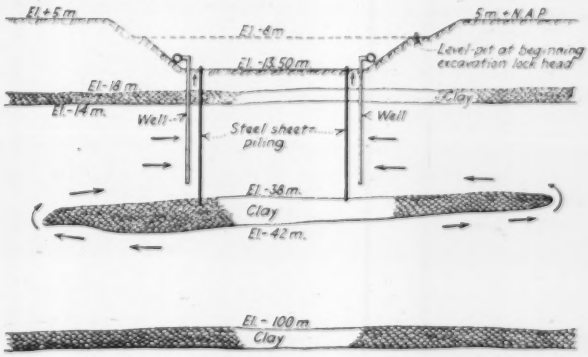


FIG. 6—SUBSURFACE CONDITIONS AT SITE OF LOCK EXCAVATION

As can be seen from Fig. 3, each end of the lock is equipped with two conduits on each side. This construction makes it possible to repair or replace any one of the conduit valves and still retain three-quarters of the nominal filling capacity.

Concrete has been adopted as a structural material for the whole superstructure of the lock walls as well as of the chamber walls. Only quoins, sills and copings are made of granite. In general, a rather rich mix of concrete has been used. For the portion below sea level, 300 kg. of portland cement and 60 kg. of trass have

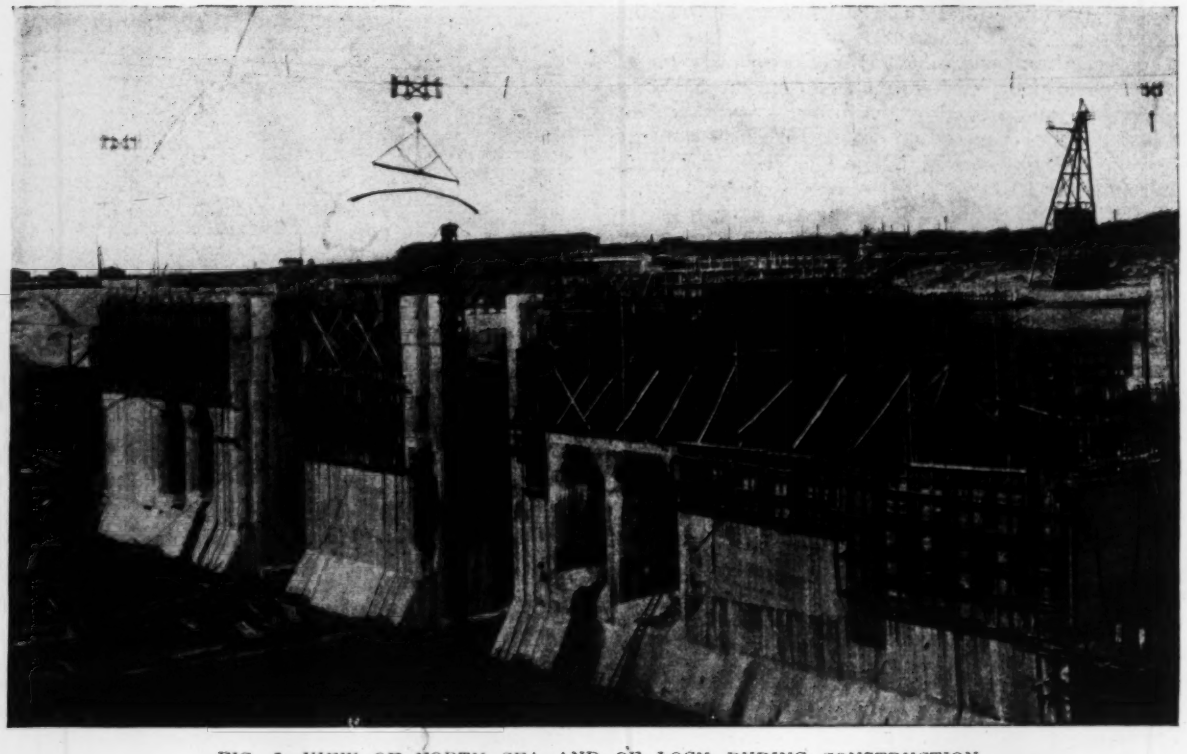


FIG. 7—VIEW OF NORTH SEA AND OF LOCK DURING CONSTRUCTION

been used in each cubic meter of concrete. For the upper portion, 270 kg. of cement and 54 kg. of trass have been used per cubic meter. Numerous vertical and horizontal contraction joints have been provided. The vertical joints are rendered watertight by means of sheet copper strips and asphalt tubes.

In order to keep down the quantity of fresh water pumped out from the space beneath the clay layer, the construction of the outer end of the lock was not begun until that at the inner end was nearly completed. Each job was made into a separate contract, so that it was necessary to deal with two different contractors. The contractor building the structures at the canal end of the lock used a concrete plant consisting of towers and chutes, which enabled all the concrete to be distributed from one central part without any further handling.

The contractor on the North Sea end of the lock used four cableways for the transportation of the concrete. Both plants had the same capacity, about 60 to 70 cu.m. per hour. All the aggregates were measured mechanically and the cement and trass were mixed together before entering the concrete mixer.

Field tests were made regularly. Each test consisted of eighteen 12-in. cubes which were tested in a field laboratory equipped with a 500-ton vertical testing machine. Three samples were tested after each of the following intervals: one week, four weeks, two months, six months, twelve months and twenty-four months. The concrete was very fluid, as is evidenced by the fact that the laborers sank into it up to their knees while working.

The average of the tests made between July 15 and Oct. 15, 1927, is as follows:

Strength after			
One week	107 kg. per sq.cm.	or	1,522 lb. per sq.in.
Four weeks	168 kg. per sq.cm.	or	2,390 lb. per sq.in.
Three months	227 kg. per sq.cm.	or	3,229 lb. per sq.in.
Six months	242 kg. per sq.cm.	or	3,442 lb. per sq.in.

The average of tests of concrete made during the colder period of Oct. 15 to Dec. 15, 1927, is:

Strength after			
One week	52 kg. per sq.cm.	or	740 lb. per sq.in.
Four weeks	109 kg. per sq.cm.	or	1,550 lb. per sq.in.
Three months	173 kg. per sq.cm.	or	2,461 lb. per sq.in.
Six months	250 kg. per sq.cm.	or	3,556 lb. per sq.in.

At the time of writing, all the concrete work has been completed.

The operation of the lock is centralized in a control house located at the inner end of the lock giving a view of the entire structure.

Electric power is used for operation and is obtained from the Provincial Electrical Co. It is transmitted at 10,000 volts and is transformed at Ijmuiden to 220/380 volts at 50 cycles. All operating stations on the lock are connected to the control house by telephone.

For the entire project 20,000,000 cu.m. of earth had to be removed, and about 270,000 cu.m. of concrete and 22,000 tons of reinforcing steel were placed. The entire project, when completed, will cost $7,500,000. The Dutch government will provide 66⅔ per cent of the cost; the town of Amsterdam 27½ per cent, and the province of North Holland 5⅚ per cent.

[This article was written by Mr. Ringers during the latter part of last summer. Since that time the construction of the lock has been completed and the lock was opened to traffic by Queen Wilhelmina of Holland on April 29. The lock exceeds the locks of the Panama Canal in length, width and depth over the sills; the latter being 1,000 ft. long, 110 ft. wide and 40 ft. deep. The Ijmuiden lock is exceeded in length alone by the guard lock of the new Welland Canal at Port Colborne, Ont., which is 1,355 ft. long, 80 ft. wide and 30 ft. deep over the sills. Other locks of the Welland Canal have a usable length of 820 ft.—EDITOR.]

New Trunk Sewer System for Owensboro, Ky.

Bad Soil Conditions Make Tunnel Construction Necessary—Branch Sewers Laid Shallow—All Pipe Supported on Cradle

By George O. Consoer
Consoer, Quinlan & Older, Chicago, Ill.

UNSATISFACTORY sewerage and drainage facilities in Owensboro, Ky., have necessitated the design and construction of a new system of trunk sewers, on the combined plan, which will cost $1,100,000 when completed. On account of the prevalence of groundwater, the old sewers were laid at shallow depths and have been costly to maintain. The new system consists of three major trunk lines, constructed as tunnels in a clay stratum, with branches laid in open cut nearer the surface. In this way the difficulties and heavy costs of building large sewers under unfavorable soil conditions have been avoided.

At preliminary meetings with the city officials it was decided that the plan to be adopted must furnish trunk service to the entire city, that it must be financed by a general bond issue and that it must include sufficient branches so that by means of road ditches or lateral sewers all sections of the city could secure immediate relief following its completion. Laterals, where desired, were planned to be put in by frontage assessment.

The prevailing soil condition in Owensboro is a top layer of sandy clay from 4 to 10 ft. thick which grades into a sand layer from 10 to 20 ft. deep. The sand layer grades, in turn, into a clay layer of varying thickness and consistency, under which lies coarse sand and gravel. Except for a short distance from the river, the groundwater stands within a few feet of the surface; therefore ordinary sewer construction in open cut can be accomplished only by using tight sheeting. Much difficulty is encountered in foundations for the larger buildings at 6- to 10-ft. depths.

Many cave-ins have occurred over the old sewers. In some cases during heavy rains holes have been formed in the streets 50 ft. wide on top and 10 or 15 ft. in depth at the sewer break. The chief cause of these breaks has been the surcharging of the existing sewers during heavier rains, causing distortion and collapse in

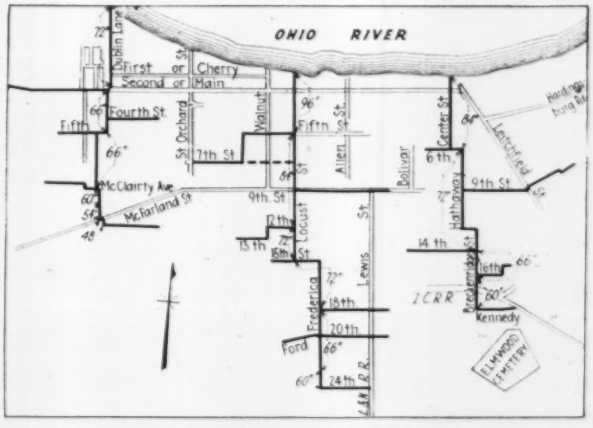


FIG. 1—THREE MAIN TRUNK LINES USED IN OWENSBORO'S NEW SEWER SYSTEM

sections of pipe which had previously cracked because of the weight of the backfill, impact or settlement. The soil then washed into the broken sewers, undermining and wrecking pavements, water mains and other utilities, and endangering buildings in the affected area. Single breaks have involved a repair expense of $4,000 to $5,000 each and the total expenditures for all breaks in 1927 was $20,000. Clearly this was a condition requiring remedy for financial reasons as well as for improvement of the health and comfort of the city's inhabitants.

The first step taken in the design was the making of an accurate topographical map with contour interval of 1 ft., showing all existing sewers, drains, ditches, streets, pavements and buildings embracing an area extending half a mile beyond the city limits in all directions. Tentative plans were then developed using runoff tables based on the formula $R = CA^t$, with values of C varying from 0.6 to 2 depending on the slopes and probable development of the area involved. Five plans were selected as worthy of further consideration, and borings were taken at 1,000-ft. intervals for the purpose of estimating and determining the most favorable grade locations. Finished estimates were then prepared narrowing the choice to two plans, one providing two main trunk lines and the other providing three main trunk lines to the Ohio River, the cost of the two plans being substantially the same. Alternate estimates for tunnel and open-cut construction showed a large advantage in favor of

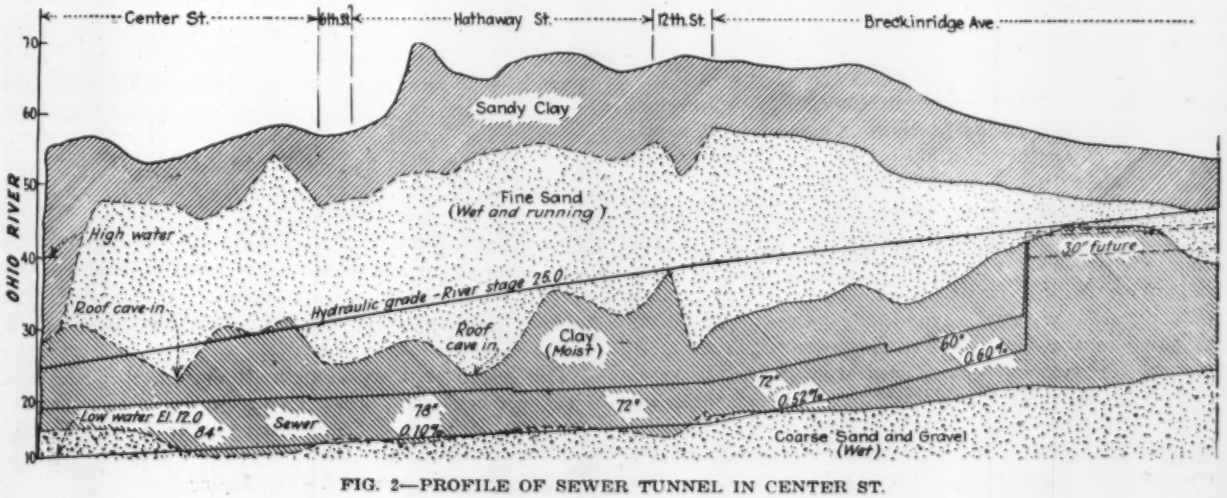


FIG. 2—PROFILE OF SEWER TUNNEL IN CENTER ST.

tunnel construction, provided the grade could be kept in the lower clay stratum. The plan calling for three trunk lines was selected because branch sewers for relief of the old system and to serve new areas were estimated to be somewhat cheaper under this plan. Fig. 1 shows the plan with branches as finally adopted and now being constructed. The final design was made by the rational method, using the Cairo rainfall curve and designing for the maximum five-year storm with an accumulated rainfall of 1.6 in. per hour.

All grades for calculating capacities and sizes were figured along an assumed hydraulic grade line some 5 to 15 ft. above the top of the sewer tunnels, sloping upward from an assumed elevation of 25 ft. at the riverbank. The figure of 25 ft. was selected as that stage of the river at which maximum storms were likely to occur. In determining this figure, the stages of the river were plotted from government records over a ten-year period. Against this graph were plotted the storms for the same period, giving a single picture of the expected river stages during storm periods.

Before determining the final grade line, soil borings were taken every 300 ft. on all proposed lines and the grades and sizes designed so as to secure the most favorable soil conditions for construction. It was found that laying the trunks and portions of the larger branches through the deep clay layer and laying the remainder of the branches shallow with flat grades and using large sizes would be the most economical construction. An added advantage of the deep placing of the tunnels is that additional capacity over the design figures will be furnished for storms occurring at low-water stages of the river.

The material for all tunnel construction was specified as plain monolithic concrete, 1 : 2½ : 4 mix, allowing either circular or horseshoe sections to be used. Branches were specified to be built of monolithic concrete, segmental block in concrete cradle or concrete pipe in concrete cradle, for the larger sizes; and alternate tile pipe in cradle or concrete pipe in cradle for the smaller sizes. Cradling was deemed necessary on all pipe because of past unfavorable experience with settlement and cave-ins on uncradled pipe. Alternate bids on either deep tunnels or shallower open cut were allowed on certain sections, and in almost all cases the tunnel bids were cheaper. Drop manholes were placed at construction shaft locations wherever possible, being a combination of access manhole and drop manhole (Fig. 3).

The final estimated cost, including all expenses, amounted to $1,200,000 and a proposal to issue bonds to this amount was approved at the November, 1928, election. For contract purposes, the work was divided into three sections and advertised in May, 1929. Nine bids were received and the entire contract awarded to Thomas D. Nolan, of Detroit, at a bid price of $1,098,000, which was 3 per cent under the estimate.

To date, a little more than one-half of the trunks have been constructed by pneumatic tunneling methods, using air pressures varying from 8 to 15 lb. The most interesting feature of the construction has been that the difficulties encountered have closely paralleled those anticipated in the design. Fig. 2 shows the location of several cave-ins and heavy roof work which occurred at breaks in the deep clay layer through which the sewer is being laid. Except for the placing of the tunnel in this clay stratum the entire construction would undoubtedly have been extremely difficult.

Wherever there has been a good clay roof several feet thick over the excavation, which has been the case in 95 per cent of the work done to date, progress has been rapid on the tunneling, averaging 14 ft. per shift per day. Under these conditions the mining has been carried forward over a full half of the heading at one time, and only loosely spaced 2-in. longitudinal timbering supported by a semicircular steel channel ring has been used over the top half of the excavation. In places where the clay roof has been very thin or small sand pockets have been encountered, progress has been slower and more dangerous and costly. Much greater difficulty is encountered under these conditions in holding the necessary air pressures Solid 3-in. timbering is used over the roof and the heading kept partly timbered at all times, the excavation being removed in seven separate sections. In several cases large amounts of cement grout have had to be forced into the surrounding soil and allowed to set before the air pressures could be maintained.

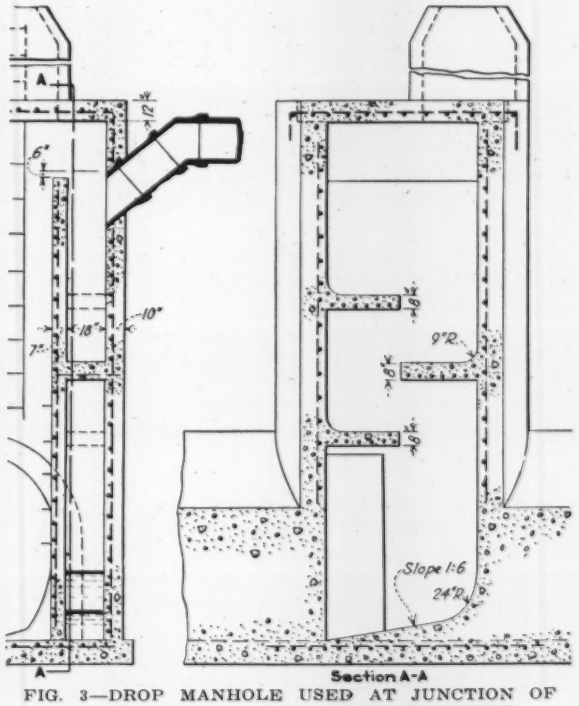


FIG. 3—DROP MANHOLE USED AT JUNCTION OF TRUNK SEWER AND SHALLOW BRANCHES

The greatest difficulties have been encountered in sinking the construction shafts through the wet sand layer. Solid steel sheet piling down to the clay has been used, and in all cases except one it has also been necessary to install a vertical airlock before the shaft could be completed and tunneling started. Horizontal airlocks in the tunnels are installed as soon as sufficient progress from the shaft has been made and a 1,000-ft. drive in each direction from the shaft is then made. At the beginning of operations some tunnel work was attempted without the use of compressed air, but this proved unsuccessful, and all work is now being done under air pressure.

The design work was done by the writer, J. C. Keeley, H. Owen and the former city engineer, C. A. Brown. Construction work is being supervised by E. M. Shifley, present city engineer, and by resident engineers, Joseph Schudt, C. A. Brown and J. C. Keeley.

Railroad Improvement in Relation to Traffic Capacity

Improving Single Track as an Alternative to Double-Tracking—Ton-Mile Traffic Study Proposed

WITH continuing increase in ton-mileage or traffic there is a demand by railroad operating officers for expenditures in physical improvements to facilitate train service. But individual demands are likely to be modified or negatived by superior officers who may not realize the local conditions of different operating districts or who may have to adjust the several demands to the railroad's financial conditions. To meet this situation, a production bureau to consider the ton-mileage output of operating districts was proposed at a meeting of the American Association of Railroad Superintendents by Bertram H. Mann, consulting signal engineer of the Missouri Pacific Railway. Production bureaus for the purposes of increasing the amount and economy of output are maintained by many manufacturing concerns and by railroads in regard to shop work, and the plan proposed is to apply the method to traffic problems.

In measuring the operating efficiency of a given district or division on the basis of output in gross ton-miles per train-hour, an important item is the actual running time of freight trains, or the time consumed in movement over the district. To reduce this period it is necessary that idle time on the road, due to waiting on sidetracks for following or opposing trains, and stopping for coal or water, should be reduced to a minimum. In Mr. Mann's opinion, such lost time should not exceed 20 per cent of the total time that the train crew is under pay. This reduction calls for a particular study of the grade conditions, and the location of passing tracks, signals and other features on the division, with a view to making changes that will expedite train movements. Such improvements may be as effective as more costly double tracking or grade reduction.

Methods by which running time may be saved are listed as follows: (1) revision of methods of locomotive repairs; (2) revision of methods of train inspection in the yard and on the road; (3) designing tenders for increased capacity of fuel and water; (4) rearrangement of passing sidings and coal and water stations; (5) avoiding the stopping of through trains to pick up short loads; (6) rearrangement of signals and interlocking plants, so that trains may move by signal indications without regard to superiority or train orders; (7) improved communication (by radio or other means) on the triangle between the dispatcher, engineman and conductor.

A study of this kind on the 56-mile single-track Kansas City district of the Missouri Pacific Railway led to a rearrangement of sidings and signals and the installation of remote-control switches, with a reduction of 30 to 70 per cent in train delays, as noted in *Engineering News-Record* of Dec. 15, 1927, p. 954. With the controlled manual and automatic block signals on this district the trains are governed entirely by signal indications without train orders. A second track would have involved much heavier expenditure and would have been needed only at periods of heavy traffic. Before the improvement the high record on this district was 25,000 gross ton-miles per hour, with about twenty trains daily in service. Since then the records have been from 35,000 to 40,000 gross ton-miles per hour with fifteen to seventeen trains. In the same period the record on the St. Louis district was from 23,500 to 37,500 gross ton-miles per hour, with 21 to 25 trains daily. Although a considerable amount of double track has been laid on this latter division, its increase in gross ton-miles per hour in the months of peak traffic was no greater than on the single-track Kansas City district with its relatively inexpensive improvements.

A special point urged for this latter class of improvement is that the operation of heavy traffic on single-track lines is economically practicable not only on outlying divisions but also on districts or divisions adjacent to large terminals (such as the Kansas City district instanced above), on which it is important to insure against traffic congestion. Some extracts from Mr. Mann's paper are given below:

At present, as a rule, a budget committee of the best minds on the railroad division segregates the particular improvements which should be given preference during the coming year. This is checked and corrected by the general officers next higher up. Later the general headquarters picks out from the list such items as in the opinion of the executives, from their broader viewpoint, will be best suited as a foundation on which their future reputations will be built.

Commercial corporations have all of this and the testing laboratory as well. The railroad should not be distanced. It has lacked solely the right unit for comparison of budget items and a way to rigidly connect the detail of the losses and wastes to the ways proposed to correct them. Such a connection makes clear, in comparison, whether a certain water station costing $50,000 will produce more units of productivity than will a lap siding, an interlocking plant or a change in the locomotive, and whether any or all of these will produce more units than a second main track. In these days of multiple organizations there is one more channel for improvement; one that will set up the proper balance between the power and roadway, or the fitting of the roadway to the power and the power to the roadway, to reduce to a minimum the loss and waste by idle freight train time.

In these days of "dependable on time" arrival of merchandise at destination, a dependable reduction in the average delay of a train may immediately be used to increase the trainload. The complete result includes both an increase in productivity through more load or more speed, or both, and a reduction in direct freight train expense. In formulating policies to control the expenditure of additional capital, first of all should be determined what are the enemies of productivity. Idle time is one. Lack of knowledge and lack of co-operative sense are others. The economist in business plans so to manage and control his operations as to (1) do the largest volume of business possible, (2) on the smallest amount of invested capital, and (3) so produce the greatest amount of net profits. We need this scientific approach to problems of the railroad. The cost of adding extra tracks has increased largely, the demand for more facilities is growing greater. But 30 to 40 per cent of the potential earning power of the freight train is lost under present methods. New methods must come.

It is now everywhere taken for granted that no money will be spent for new locomotives or for new bridges except after thorough scientific research into every detail by trained men. It follows that the executives, from superintendent up, should have the aid of a production research bureau of technically trained men for the routine study of the freight-train district, with a view of steadily increasing the ton-mile output per unit through a step-by-step lowering of the loss and waste due to idle train time.

Educators List Greatest Engineers

As the result of a questionnaire sent to the deans of American engineering schools by Carl T. Humphrey, head of the Villanova School of Technology, two lists of the world's outstanding engineers have been compiled. The ten foremost engineers of the last quarter century are named as follows: Charles P. Steinmetz, Thomas A. Edison, John F. Stevens, John Hays Hammond, George W. Goethals, George W. Westinghouse, Guglielmo Marconi, Henry Ford, Ralph Modjeski and Herbert Hoover.

As the five greatest engineers of all time, the deans selected James Watt, Leonardo da Vinci, Thomas A. Edison, James B. Eads and Ferdinand de Lesseps.

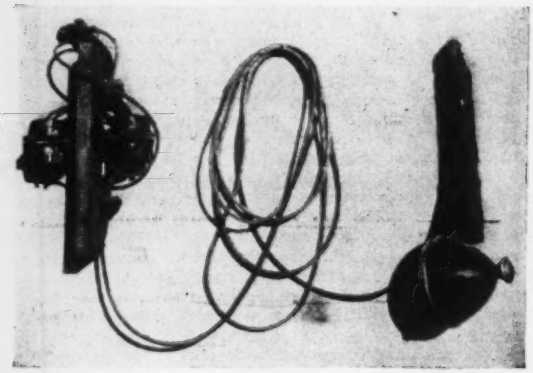
From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Portable Auto Spotlight Handy in Tunnel Work

By Aaron Evans
Inspector, City Engineering Department, Seattle, Wash.

A BRIGHT portable light is often desirable in tunnel work, especially in concrete-lining operations. The portable light illustrated here is devised for the use of inspectors in Seattle's Hanford St. sewer tunnel. It consists of a heavy-duty plug, a short piece of rubber cord, two 50-watt 8-16-24-volt bell-ringing transformers, about 20 ft. of cord, a toggle switch and an ordinary automobile spotlight mounted on a wooden handle. Common auto-



PORTABLE SPOTLIGHT OUTFIT FOR TUNNEL WORK

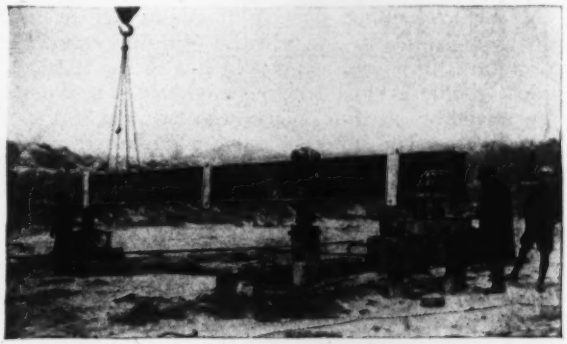
mobile bulbs were used. Usually the 16-volt connection on the transformers was used, giving intense white light.

The light proved very satisfactory and was used extensively by foremen, concrete spaders and other contractor's employees as well as by the inspectors. More satisfactory service would be given by a 150-watt transformer with an easy voltage regulator. Some voltage regulation is necessary to allow for the line drop found in construction wiring, and to give the necessary white intense beam.

Pulling Resistance of Concrete Piles at Akron Sewage-Works

By A. B. Backherms
Sewerage Engineer, Akron, Ohio

TEST methods and test results of pile-pulling, which have usefulness, were developed in building the Akron sewage-treatment plant on the banks of the Cuyahoga River. During the life of the plant there will be periods when the river is above normal, and during these periods one or a number of the humus tanks may be empty. As a result of the high stage in the river, the groundwater elevation will be high and will produce an uplift pressure on the bottom of the tanks, tending to float them. To provide for this contingency, reinforced-concrete piles 14x14 in. by 24.5 ft. were used.



ARRANGEMENT FOR PULLING CONCRETE TEST PILES
Sling from overhead cableway used in moving I-beams.

The specifications called for driving and testing four test piles to ascertain the frictional resistance in pulling.

Method of Making Test—The apparatus as illustrated consisted of two 24-in. 80-lb. I-beams, two 25-ton jacks and one hydraulic jack having a diameter of piston of 4½ in. and a capacity of 60 tons. The equipment was set in such a manner as to obtain the multiplying effect of a lever, by placing the fulcrum under one end of the beam and the hydraulic jack under the other end. The test pile was attached near the fulcrum and the uplift load was applied by means of the hydraulic jack. It is obvious that any pressure exerted on the ground by the reactions at the fulcrum and the hydraulic jack would tend to increase the frictional resistance of the pile. To overcome this, wooden piles were driven and used to take the reactions at the end of the beam.

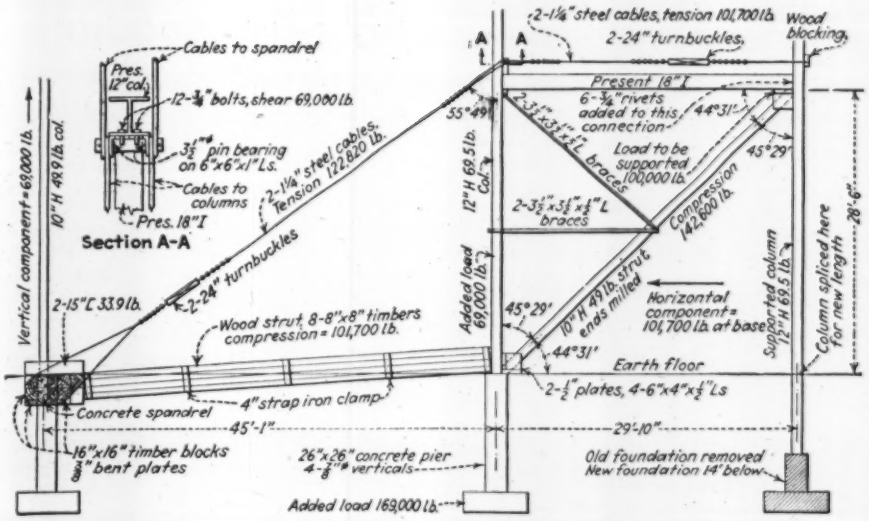
Test Results—One pile was driven out of plumb and developed the minimum resistance of 170 lb. per square foot. Other results were 300, 380 and 600 lb. per square foot, an average of 360 lb. per square foot, which was the figure considered. It was realized that all piles would not be driven absolutely plumb and the low average recognized this contingency.

Novel Support Holds Columns During Foundation Alterations

By S. D. Werner
Chief Estimator, Charles R. Hedden Co., Newark, N. J.

A SUPPORT which was essentially a guy derrick using an existing column as the mast and a 10-in. H-beam as a boom was developed for holding two columns of an interior bent during foundation alterations in a typical four-column bent mill building of the Florence Pipe Foundry & Machine Co., Florence, N. J. The necessity of using a steam shovel around and under the columns to install an irregular concrete pit 45x200 ft. in plan and 18 ft. deep under the two columns prevented the use of conventional underpinning or shoring.

Details of the support are shown in the accompanying illustration. The complete rig was installed and the column cut off in 32 hours, and sixteen hours later the steam-shovel excavation was completed and hand excava-



SUPPORT FOR BUILDING COLUMNS DURING FOUNDATION ALTERATIONS

tion begun for the new footings below the new floor level. A sag of ⅜ in. was allowed for, being calculated in advance. The column splice was milled for ⅛ in. clearance and a perfect fit was obtained without any shimming of the base plates. During the 84 hours of suspension the main cables were stretched 10 in. and the upper cables 3 in.

The cost of all material for one column was $469 and the labor for erection and removal $446, a considerable saving over the amount allowed in the estimate. Wood was used in making up the main strut, because this material was on hand.

Railroad Crane 350 Ft. Away Raises Wrecked Gantry From River

By W. E. Lewis
Superintendent, Armour Fertilizer Works, Wilmington, N. C.

A 55-TON railroad wrecking crane operating from a distance of 350 ft. raised a wrecked traveling gantry wharf crane from the bottom of the Cape Fear River at the Navassa (N. C.) plant of the Amour Fertilizer Works. The gantry, of the ship-unloading type, was blown off the end of its dock into 35 or 40 ft. of water during a severe windstorm on Aug. 25. The gantry, 80 ft. high and weighing 95 tons, straddled, on a 27-ft. gage track, a high trestle wharf running parallel to the shore line. It was equipped with a cantilever boom 77½ ft. long which carried a ¾-cu.yd. clamshell bucket.

The gantry went off the dock endwise, and lay on the bottom in the position shown in Fig. 1. After divers had investigated the wreck, the following methods were adopted in salvaging the crane:

Falsework piling 65 and 70 ft. long were driven in six clusters, as shown in Fig. 1, crossbraced and capped, and three 30-in., 200-lb. steel beams were placed transversely across the crane, two beams placed close together over the boom and one across the lower end of the legs. Slings carrying six - sheave blocks hung from the beams close to the outside of the crane, the two beams over the boom carrying but one set of blocks. Because of the marshy tidal flat between solid ground and the dock, the wrecking crane could not be brought nearer than 350 ft. to the work. Two ¾-in. cable lines were run from the wrecker through snatchblocks in the dock

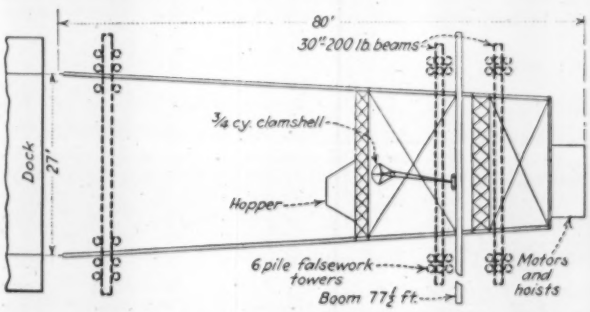


FIG. 1—PLAN OF WRECKED GANTRY CRANE, SHOWING POSITION AS IT LAY ON RIVER BOTTOM AND ARRANGEMENT OF FALSEWORK FOR LIFTING

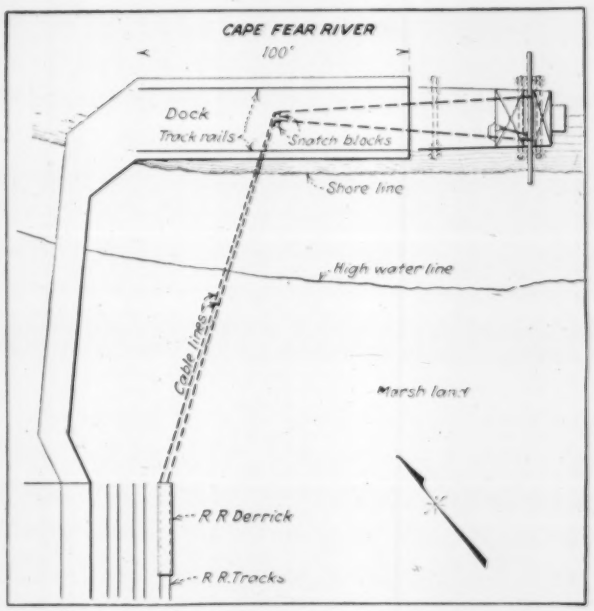


FIG. 2—POSITION OF RAILROAD CRANE IN SALVAGING GANTRY CRANE

trestle to the blocks hanging from the beams, one line to each side of the wreck, as shown in Fig. 2.

Hauling in on these lines raised both sides of the gantry simultaneously. When the head end of the crane had been pulled up part way, it was lashed in place and the hauling lines were transferred to the set of blocks on the lower end, which was raised a short distance, the hauling lines again transferred and the process repeated.

As parts of the crane appeared above the water they were burned away and were lifted onto barges by a float-

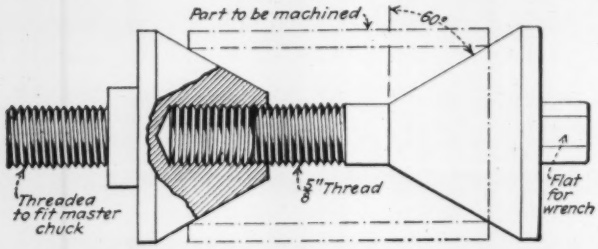
FIG. 3—VIEW OF SALVAGING OPERATIONS

ing derrick with the idea of salvaging as much of the wreck as possible for rebuilding. As a result, more than 90 per cent of the machinery and framework was saved and the crane has been rebuilt and is again in service.

The salvage work was done by the Atlantic Coast Line Railway, supervised by George Thomas, engineer of bridges, and was in direct charge of C. T. Nelson, supervisor of metal bridges. The writer represented the Armour company on the work. Rebuilding the crane was done by the Armour company forces.

Lathe Chuck for Emergency Use in Field

BECAUSE the machine shop equipment in the field is often limited, the adjustable lathe chuck shown in the accompanying illustration has many uses on repair work of all kinds. The chuck, which can be made on the job from a piece of cold-rolled shafting, consists



ADJUSTABLE CHUCK FOR MAKING REPAIRS ON THE JOB

of two conical members, one fastened to the master chuck of the lathe, the other fastened to the first by a screw allowing adjustment to accommodate different lengths of parts to be machined. This equipment has been found valuable in machining odd and standard-sized sleeves and collars, in dressing tubular drills and on repair work that would ordinarily require special mandrels to handle changed diameters. The tool is self-aligning.

Job and Office Note

CORRECT AND ADEQUATE SIGNS for state highways have been considered so important by the New Mexico Highway Department that it has created a separate division which will devote its entire attention to erecting directional, warning, caution and informational signs on the 6,000 miles of maintained highways in the state. The division has been furnished with an especially designed truck which carries within itself all necessary tools and fixtures, besides the signs to be erected. This truck can stay in the field indefinitely, as long as contact with shipping points is made at suitable intervals.

Letters to the Editor

Erection Stress in Welding Construction

Sir—Welding may be increasingly employed in assembling structural steelwork in future and if so structural parts will be erected separately in a structure and subsequently welded together to function in unison as a single member. Such manner of assembly causes erection stresses in the individual parts before welding, which stresses will remain permanently in the structure and which, when combined with the stresses resulting from subsequent loading on the member after it has been welded, will be higher than they would have been if such member had been assembled and welded (or riveted) while lying fully supported upon a shop floor. It appears that these stresses are sometimes very material and not properly to be neglected.

As a case in point we may take such a steel-deck floor construction as is proposed in *Engineering News-Record* Aug. 29, 1929, p. 326, consisting of shallow steel beams, placed rather closely together, on top of which are to be placed continuous steel floor plates which are then to be welded to the tops of the beams.

The accompanying diagram represents, in the usual manner, the stress distribution on a section AA of such a built-up member. Let M' = bending moment induced by the loads permanently upon the supporting beam before welding; M'' = bending moment induced by only such loads as come upon the floor construction after welding; f_1' and f_2' = extreme fiber stress, respectively, in bottom and in top of beam due to M'; x' = distance to neutral axis $N'N'$ of supporting beam (exclusive of floor plate), and I' = moment of inertia of section of supporting beam about $N'N'$; f_1'', f_2'' and f_2''' = extreme fiber stresses, respectively, in bottom and in top of supporting beam and in top of built-up floor, due to M''; x'' = distance to neutral axis $N''N''$ of built-up floor, disregarding initial stresses, and I'' = moment of inertia of built-up floor about $N''N''$; f_1 and f_2 = total extreme fiber stress, respectively, in bottom and in top of supporting beam due to combined moments M' and M''; x = distance to neutral axis NN of stresses resulting from combined moments M' and M''.

In accordance with the usual theory of flexure we may write:

$$f_1 = f_1' + f_1'' = \frac{M'x'}{I'} + \frac{M''x''}{I''} \qquad (1)$$

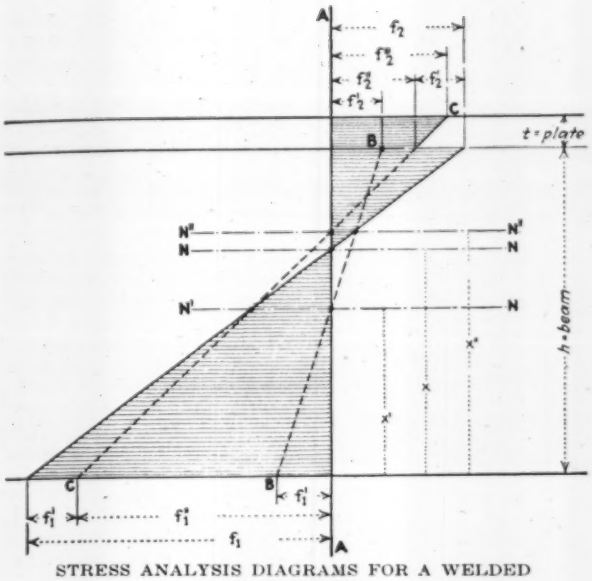
$$f_2 = f_2' + f_2'' = \frac{M'(h-x')}{I'} \quad \frac{M''(h-x'')}{I''} \qquad (2)$$

$$f_2''' = \frac{M''(h+t-x'')}{I''} \qquad (3)$$

$$x = \frac{h f_1}{f_1 + f_2} = \frac{\frac{M'x'}{I'} + \frac{M''x''}{I''}}{\frac{M'}{I'} + \frac{M''}{I''}} \qquad (4)$$

In the diagram the distribution of stresses in the supporting beam due to M' alone is represented by the abscissas from AA to the dotted line BB. The distribution of stresses resulting from M'' alone is represented by the abscissas from AA to the dotted line CC. Finally, the distribution of stresses in the built-up floor member due to the combination of M' and M'' is represented by the shaded area, and the neutral axis is at NN, which is not at the center of gravity of the section of the supporting beam nor at the center of gravity of the section of the built-up floor member, but is intermediate between the two and varies in its position as the relative magnitude of M' and M'' changes. This migratory neutral axis is somewhat novel.

When the above analysis was applied to the tables for such floors, as published in Bulletin 3 of the American Institute of Steel Construction, it was found that the safe load per square foot, as given in said tables, produced stresses which in some cases exceeded 20,000 lb. per square inch and in



STRESS ANALYSIS DIAGRAMS FOR A WELDED STEEL FLOOR

many cases were well beyond 18,000 lb. If perchance in the course of construction the fireproofing beneath such a floor should be attached before the welding of the floor, then the unit stresses would be even greater.

It might be suggested that these excessive stresses could be overcome by proper erection methods such, for instance, as shoring up under the floor before welding so as to take the initial deflection out of the beams. In fact this idea could be carried further and the beams could be shored up to such an extent that they would take an initial bending upward to any predetermined degree and thus, *theoretically*, the strength of the completed floors could be considerably increased beyond "normal" strength, but whether such things are practicable and reliable is questionable.

However, it is not the writer's purpose further to complicate this discussion at this time, but merely to point out that in certain cases these erection stresses are a factor that should be thoroughly analyzed and taken properly into consideration in the final design.

New York City,
April 11, 1930.

H. C. TOENSFELDT,
Consulting Engineer.

Designer Certification and Column Formulas in New York Building Code

Sir — The revised building code of New York City, extracts of which were recently published in your periodical, permits an increase of working stress of rolled steel from 16,000 to 18,000 lb. per square inch, or an increase of 12½ per cent. This is a move in the right direction. However, from a consideration of what follows one can readily appreciate that the application of these increased unit stresses should be restricted to competent designers. This fact should place additional emphasis on the importance of incorporating the proposed clause in the new building code, which requires affidavits from the designing engineer as to the safety of the structure before a certificate of occupancy is granted. The writers believe that the committee would not have released the increased stresses if they were not satisfied that their application would be restricted to qualified designers only. It is but logical to assume that a recommendation for higher working stresses, with a corresponding reduction in the factor of safety, should automatically restrict the application of the formula to competent designing engineers and provide for their indorsement that the structure is safely designed in accordance with the provisions of the code and that the building has been built as designed.

The committee of the Merchants Association which recommended the amendments to the existing code evidently adopted, *in toto*, the American Institute of Steel Construction specifications for design; for we find that this committee has discarded the practical straight-line column formula and substituted instead the cumbersome modified Rankine formula.

The writers do not question the accuracy of the Rankine formula when used under laboratory conditions, and are aware of much that has been written on the merits of the two classes of column formulas. It is not their intention to reopen a discussion as to their relative mathematical accuracy, but rather to call attention to the inconsistency of discarding, at this time, the straight-line and adopting instead the curve-line formula.

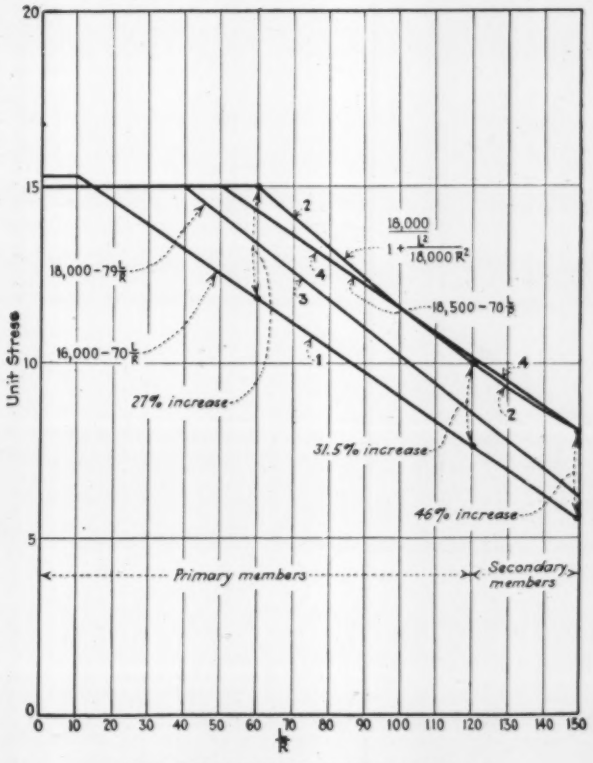
The accompanying diagram plots the present (16,000 — 70 l/r) straight-line formula (1) and the adopted American Institute of Steel Construction curve-line formula (2).

An inspection of the diagram will show that under the new city code column formula it is uneconomical to use a smaller l/r value than 60 and also that compared with the present code, the permissible increase in stress at this l/r value is from 11,800 to 15,000 lb. per square inch, or 27 per cent. At an l/r value of 120 the permissible increase in stress is from 7,600 to 10,000 lb. per square inch, or 31½ per cent.

The inconsistency here is to restrict the increase in the more certain and easily ascertained tensile stresses to 12½ per cent and, at the limit of design for primary members, permit an increase of 31½ per cent in the uncertain and difficultly ascertained column stresses.

The straight-line (3) graphs the formula 18,000 — 79 l/r, which is a uniform increase of 12½ per cent at any l/r value. This formula also reduces the uneconomical limit from 60 to 39 l/r. This, or the more easily remembered formula, 18,000 — 80 l/r, is recommended by the writers for adoption.

We must not forget that the curve-line formula, while probably a more accurate indicator of the actual stress in the column when the loading, bearing and metallurgical conditions are controlled by laboratory refinements, is not ideal to meet the requirements of a busy engineer who is forced by standards to select an actual column section whose



COMPARISON OF COLUMN FORMULAS

l/r value may vary considerably from the theoretical requirements.

If, however, the Merchants Association committee insists that the allowable column stresses be increased to that given by its recommended formula, then, by all means, let us remove the kinks and straighten out the line as in the formula $18{,}500 - 70\ l/r$, graphed by the line (4). The discrepancy between lines (2) and (4) will not be greater than the selective range of available column sections.

A straight-line formula should also be substituted for the curve-line formula recommended by the committee for the compression flanges of beams.

The New York City code is used as a model for other and smaller cities which have adopted its provisions more or less blindly on the assumption that we, with our skyscrapers and massive construction, seek both accuracy and facility in the formulas we use. Any inconsistency which we incorporate in our code may be multiplied and be the subject of future criticism and resulting lack of confidence.

This letter is not intended as a criticism of the worthy work done by the committee that recommended the design specifications of the American Institute of Steel Construction. Its work was to lay down conditions which approach the ideal and give the commercial designer some haven wherein he may occasionally check the more approximate methods he uses in design. Its purpose is to stress the importance of competent design and supervision under the conditions set up.

WILLIAM L. UNGER,
JOHN C. SCHULZE,
Licensed Professional Engineers.

New York, N. Y.,
April 22, 1930.

Rigid Frames and Continuity in Tall Buildings

Sir—We are at present enjoying a bull market in "Wind Stresses in Tall Buildings." Long-delayed and much-needed publicity is being given to this important and complicated subject and to the development of adequate and compact connections. Little attention seems to have been given, however, to the radical changes in distribution of stress caused by these connections.

End moment due to gravity loads may be relieved through strain of a weak connection, but resistance to wind load has to be developed by stiffness of joints, and this necessity has led to the development of the heavy wind connections which have recently come into general use. The T-type, or split beam connection, which in the heaviest case connects each flange of the beam to the column face by sixteen 1-in. diameter rivets in tension, is a very stiff connection which definitely fixes the end of the beam, the relief due to strain of connection being negligible. The danger of this type of connection is obvious, as it undoubtedly induces high secondary stresses in the beams and columns. Once this fact is recognized, the natural conclusion is to design the connection for the dead + live + wind moment it actually carries, and to redistribute the metal in beams and columns more economically.

The *Journal* of the American Concrete Institute, December, 1929, gives a simple but logical method of approximating stresses in rigid frames by repeated distribution of unbalanced moments to the members meeting at a joint, in proportion to their rigidities. By means of this method or similar methods secondary stresses due to gravity loads can readily be investigated. It is not suggested that every beam should be designed for its exact maximum moment, but rather that by means of studies made at occasional floors some idea can be had of the importance of these secondary stresses and the knowledge used in a general way to economize in floor steel and to strengthen columns where necessary.

In the lower floors of a tall building, where the rigidity of the column is several times that of the floor girders connecting to it, the girders are almost rigidly fixed, any unbalanced moment at a joint being absorbed almost entirely by the heavy columns. Near the top of a building, where the rigidity of the column may be small compared with that of the beams, the stiffness of the beams provides the greater part of the resistance to unbalanced moment, and consequently end moments are modified by conditions of loading and lengths of neighboring spans. Although every case must be judged on its merits and results will vary with lengths of bays and distribution of live load, the writer believes that generally it will be found sufficient to design floorbeams for a moment of ± 0.7 of the simple span moment due to dead + live load at normal unit stresses or for a negative moment of 0.7 of the gravity load moment together with the end wind moment at increased unit stresses. In a case recently investigated the secondary stress in a light wall column due to a rigid wind connection was found to exceed 7,000 lb. per square inch and the column under worst conditions of loading was stressed up to the elastic limit.

In these days of cheap technical labor and high construction costs it seems rather surprising that no effort has been made to treat the design of tall buildings more scientifically by taking advantage of the undoubted continuity of members, and so economize in cost.

JOHN PORTAS,
Of Monsarrat & Pratley,
Consulting Engineers.

Montreal, Que.,
March 28, 1930.

Standpipes and Water Towers

Sir—In *Engineering News-Record* of June 20, 1929, reference was made to standpipes and water towers, the appearance of which had been improved by brick or concrete facing for exterior walls.

I inclose a photograph of a water tower designed and built under my supervision at the Eastern Hospital for the Insane, Richmond, Ind., in 1901-02. This tower conforms in archi-

STANDPIPE AT RICHMOND, IND., ERECTED IN 1901

tecture with the buildings of the institution. The tower is 20 ft. in internal diameter and is 110 ft. high, with reinforced concrete 4 in. thick at the top, 12 in. thick at the bottom, faced with the same brick as is used in the other buildings. The brick were used as forms on the outside, or forms were used only on the inside of the cylinder. The steel standpipe is entirely separate from the exterior wall, which was built to improve the appearance and also to keep the water at a more satisfactory temperature through summer and winter. The cost figures, as nearly as I can get at them at this time, are:

Standpipe, including erection	$4,000
Foundation, piping and valves	1,500
Reinforced concrete shell, brick faced	3,500
Total	$9,000

R. L. SACKETT,
Dean of Engineering,
Pennsylvania State College.

State College, Pa.,
May 1, 1930.

News of the Week

Municipal Investigation Bureau Urged for New York City

The Board of Estimate and Apportionment of New York City, at the request of Controller Berry, has voted increases in personnel and in budget resources, in order to create within the finance department a bureau of municipal investigation. The purpose of the bureau will be to enable city officials to keep a check against collusive or exorbitant bidding on city contracts and to prevent a recurrence of municipal abuses such as the recent sewer scandal in the Borough of Queens.

The new bureau will have a force of ten engineers, inspectors, draftsmen and computers. The chief assistant engineer of the bureau is to receive $5,000 a year, another engineer $3,120. There also is to be a sanitary engineer at a salary of $4,000, a mechanical engineer at $3,540, and an electrical engineer and a full-time engineering chemist at the same salary.

The work of the bureau will be to establish a system of control over contracts after bids have been received, with a view to showing the comparative unit prices of all public works of a similar character. This, it is thought, will do away with excessive and collusive bids.

One Town and Much Timberland Damaged by Series of Fires

Fire starting in an old covered wooden railroad bridge in Nashua, N. H., on May 4 destroyed more than 100 residences, a church, a school and several industrial plants in the southeastern section of the city and, crossing the Merrimack River, continued southward through heavy timberland. Preliminary reports place the damage at more than $5,000,000. Although no lives were lost, more than 1,000 persons were said to be homeless.

Unseasonally dry weather and the prevalence of high winds have resulted in an excessive number of brush and forest fires throughout the Eastern states, ranging from Virginia and West Virginia on the south to Connecticut and Massachusetts on the north. Every state in this area reports damage far above normal at this time of year. Pennsylvania had 200 fires in two days; New Jersey reported serious fires in ten counties, with 1,500 buildings destroyed; and the situation on Staten Island, a borough of New York City, was so serious that twenty pieces of apparatus were sent from Manhattan to aid in saving threatened buildings. The situation will continue critical throughout the East until a general rainfall.

$10,660,000 Asked to Start Boulder Dam Construction

Railroad, Highway and Town to Be Started When Money Is Provided —Budget Bureau Approves

PRELIMINARY Boulder Dam expenses have been approved by the Budget Bureau to the sum of $10,660,000. Secretary of the Interior Wilbur has forwarded the estimate to Congress with a note of explanation. The principal items are:

Start of four diversion tunnels, ultimate cost $17,000,000	$5,000,000
Spur railroad line to site	2,500,000
Initial power to drill tunnels and start job, either by purchase or building small plant	1,750,000
Confiscation of ranches and mines to be drowned out	500,000
Repayment to Reclamation Fund for expenses over the past ten years	385,000
Three miles of highway	300,000
Administration building and living quarters	125,000
Townsite surveys, water supply, and sanitation	100,000
Total	$10,660,000

When the appropriation becomes available the job will start with a spur railroad line either from Las Vegas or Chloride, Ariz. "In either case," says Mr. Wilbur, "when these spurs have reached the neighborhood of the dam a spectacular problem will be encountered. This will be that of getting a railroad down to the bottom of the canyon 300 ft. both above and below the dam site.

(Continued on Page 782)

License Law Changes in New York Vetoed by Governor

Amendments to the engineer license law in New York State passed by the legislature were vetoed by the governor. The governor stated in his veto message that engineers themselves were not in agreement as to what changes were needed. The bill as passed contained changes in the administrative sections of the law and an increase in the educational requirements.

President Is Asked to Appoint Timber Conservation Board

A delegation representing the American Forestry Association and other forest organizations appeared before President Hoover on April 30, and asked him to create a national timber conservation board to study the problems of overproduction in the forest industry and to recommend a remedial course of action for the relief of the situation. It was suggested that the board should act solely as an agency to discover the facts and to make recommendations.

The objectives of the proposed board were outlined to the President to be the determination of the important assets and liabilities in the present balance sheet of the forests and forest industries, the points of economic strength or weakness in the present forest situation, and whether present knowledge is adequate or inadequate for the formulation of sound policies and programs.

CONSTRUCTION OF BONNET CARRE SPILLWAY

This illustration shows the latest development in the construction of the Bonnet Carré Spillway, which it is thought will make New Orleans absolutely floodproof and which is now nearing completion. The illustration shows a view of the weir structure. This structure will support a needle dam. The spillway weir is over a mile long and will be capable of handling sufficient floodwater to assure a safe gage at New Orleans during high stages.

$10,660,000 Asked to Start Boulder Dam

(Continued from Page 781)

Beginning at a point 2 miles from the river, a highway must be constructed to the top of the cliffs overlooking Black Canyon dam site, a distance of 3 miles over rough and precipitous ground.

"The townsite which will be the point of residence for the working force must be laid out. Topographic surveys are to be made and town planners called in. Careful attention must be given to sanitation. A dependable water and sewer system must be installed. Water must be pumped from the Colorado River 800 ft. below. Settling basins and filtration systems modeled on those of such towns of the region as Yuma will be installed."

The government will build an administration building and living quarters for its own personnel, but the contractors must provide their own living facilities and must house their laborers.

As was noted last week, p. 737, the city of Los Angeles, the Southern California Edison Co., Ltd., and other southern California power companies, and the Metropolitan Water District of Southern California have signed power contracts with the United States government in accordance with the allocation agreement entered into March 20. Two lease contracts, one between the city of Los Angeles and the government and one between the Edison company and the government, are combined into a single document entitled a "Contract for Lease of Power Privilege." The federal government, represented by the secretary of the interior, agrees to install $21,000,000 of power-generating machinery. The two lessees are obligated to pay a rental that in 50 years would amortize the cost of the machinery with interest at 4 per cent, but they agree to pay that total in ten annual payments and to keep all machinery in first-class repair and to take care of all replacements. Title to the machinery as well as to the dam and power house structure is to remain with the government. The government sells to the lessees only the falling water.

Each lessee will operate the machinery required to supply its own allocation. The city of Los Angeles will take care of the necessary machinery to supply the Metropolitan Water District and the smaller municipalities of southern California and such power as is taken by the states of Arizona and Nevada. The Southern California Edison Co., Ltd., will operate the machinery for generation of power allocated to the power companies. Under the contract the secretary of the interior will appoint a director who will have general supervision over the Boulder dam power plant. This director will be on the government payroll.

All allocations have been made on the basis of a 575-ft. dam with a firm horsepower capacity of 650,000 hp. However, plans have been put forward that will add 7 ft. to the height of the dam and 13,000 hp. to the plant's capacity, and under the contract the government reserves the right to allocate the additional power available. The rate to be paid by the two lessees, the city of Los Angeles and the Edison company is 1.63 mills per kilowatt-hour for primary power and ½ mill for secondary power. A charge at the switchboard to allottees that are not lessees and therefore are not operating power units will be 2 mills per kilowatt-hour for primary power and ⅝ mill for secondary power.

Civil Engineers on Board of Engineering Council

Appointment of representatives to the administrative board of the American Engineering Council have been announced by Carl E. Grunsky, of San Francisco, president of the council. Those from the American Society of Civil Engineers are: H. S. Crocker, Denver, Colo.; A. J. Dyer, Nashville, Tenn.; Dean Anson Marston, Iowa State College; Frank M. Williams, Albany, N. Y.

Chamber of Commerce Surveys Nation's Problems

Public and Private Construction, Transportation and Conservation Considered at Washington Meeting

A GREATER disposition to view the evils and the responsibilities of the modern business structure was the keynote at the eighteenth annual meeting of the Chamber of Commerce of the United States, held in Washington, D. C., April 29 to May 1. An alertness born of the strenuous experiences of the last six months characterized the round-table discussions as well as the attitude of the individual. Although there was some disposition to triumph over the fact that governmental and business leadership had saved the slump from going to rock bottom, this sort of moral victory did not seem to make a profound impression. The consciousness that a preventable crash had occurred and that business leadership had failed in obviating this had the effect of leading the delegates to think about means for preventing such occurrences in the future.

Public and Private Construction

The value of adequate planning of public works in advance was brought out by Robert P. Lamont, secretary of commerce, who stated that a tabulation of construction contracts shows $334,000,000 for public projects in the first three months of 1930, an increase of 35 per cent over a similar period in 1929, the record year. In the same period of 1930, according to Secretary Lamont, municipal bond issues increased 8 per cent. Speakers at the round table on construction agreed that the stimulation of building activities after the stock-market slump started a chain of allied industries into motion and saved the day for business. That private residential construction is on the upgrade was stated by Fenton B. Turck, Jr., vice-president of the American Radiator and Standard Sanitary Corporation and chairman of the National Building Survey Conference, who said that mortgage money for small investors is growing easier. Perhaps the most constructive suggestion brought out at the meeting was that of E. J. Russell, a St. Louis architect, who suggested that business should provide a means for the small investor to gain accurate information about home building and home financing. Such an agency, he asserted, not only would stimulate construction but would prevent mistakes discouraging new home ownership.

John M. Gries, chief of the division of public construction, U. S. Department of Commerce, told of the co-ordinated effort of the federal, state and municipal governments in stepping up public construction. Declaring that residential building represents not only the largest type of construction but is in some respects the most complex, Ernest T. Trigg, president of John Lucas & Co., said that better stabilization in residential building might be promoted by the periodic vacancy survey of specific types of dwellings and business properties. Accomplishments of the State of Ohio, together with its municipalities and counties, in stabilizing construction work were told by William T. Lake, industrial director of Ohio, who spoke as a representative of Gov. Myers Y. Cooper. In that state a system was set up by which a larger number of public works contracts were let considerably earlier than would ordinarily have been the case.

Natural Resources Industries

A resolution recommending to the board of directors of the Chamber of Commerce of the United States that it authorize "an immediate study upon which may be based a recommendation for a national policy toward the reasonable conservation of natural resources, including appropriate legislation," was adopted at a round-table conference which heard representatives from the lumber, petroleum, coal and water-power industries. Possibilities of curtailment in production was the most prominent topic considered. It was held that enforced curtailment is the only solution for the problem, but before this can be done there must be a modernizing of the anti-trust laws. The only alternative, it was stated, is the formation of huge mergers to dominate each industry.

The controversy between inland waterways and railways was refought along

conventional lines at the inland waterway round-table conference. Advocates of river development pleaded for the "land-locked" Middle West, urging river development with joint rates between rail and water systems as an essential for mid-continental industry. The rail argument against waterway development was led by S. O. Dunn, editor of *Railway Age*, who stated that water transportation can be conducted only with subsidies and the actual cost is greater than rail cost. Mr. Dunn claimed that few data on waterway costs are available, those existing being inaccurate because of neglect of certain capital charges.

At the round-table conference held by the railroad interests the three topics discussed were consolidation, co-ordination of rail services with other transportation agencies and the expeditious settlement of minor rate controversies. Two resolutions were presented to this round table, the first expressing opposition to proposed congressional action amending rules of rate making and the second urging Congress to enact appropriate international air-mail-carrying contracts to facilitate international air transportation development.

Compulsory Insurance Laws

Among the many other topics taken up at the conference was a discussion of the merits of financial responsibility and compulsory insurance laws as a panacea for automobile accidents. It was stated that one-third of the motorists in the United States and one-half of those in Canada now operate under the financial responsibility law sponsored by the American Automobile Association, and that, in such states as have had the law for a considerable period, the results have been satisfactory. The experience of Massachusetts with compulsory insurance laws was said to have been unfortunate as, according to Owen B. Augspurger, accidents have increased, fraud has been practiced, and there has been general inability to enforce certain provisions of the act. Whether any such law promotes safety was questioned by Alfred Reeves, general manager of the National Automobile Chamber of Commerce, who attacked the principle of compulsory insurance on the ground that it violated the basic American principle of judging a man innocent until he is proved guilty.

Among the many declarations of policy made at the meeting were several of interest to the engineering profession. The present policy of the Reclamation Service "in developing small projects to furnish supplemental supply of water to lands which are already partly irrigated" was indorsed, as was the construction of highways by the federal government in public land states, and the development of an inter-American highway. The establishment of state insurance funds, especially for automobile accident insurance, was condemned as interfering with a business which is now being successfully conducted by private enterprise.

Official Delegates Designated to Berlin Power Conference

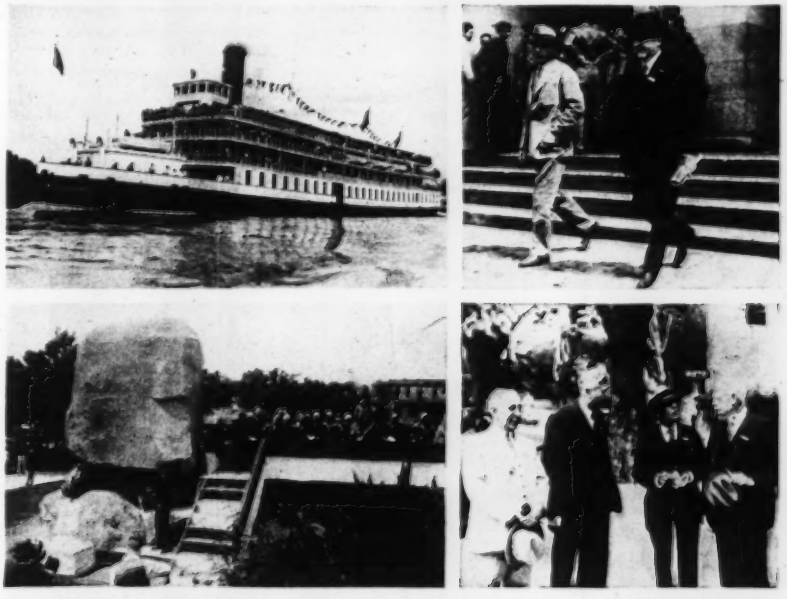
Official delegates to represent the United States government at the World Power Conference of 49 nations to be held in Berlin, Germany, June 16 to 25, were designated at a meeting of the executive board of the American committee for the conference held on May 2 in New York. Those designated are: O. C. Merrill, of Washington, chairman of the American committee; Prof. Robert Sibley, of the University of California; Henry J. Pierce, of the Electric Bond & Share Co., New York, vice-chairman of the American committee; H. M. Addinsell, of Harris, Forbes & Co., New York, treasurer of the American committee; David B. Rushmore, consulting engineer, of New York; Ely C. Hutchinson, of New York; editor of *Power;* George A. Orrok, consulting engineer, New York; H. C. Dickinson, chief of the heat and power division, U. S. Bureau of Standards; H. Foster Bain, secretary of the American Institute of Mining and Metallurgical Engineers, and Scott Turner, director, U. S. Bureau of Mines.

American chairmen to preside at important sessions of the power meeting in Berlin have also been announced as follows: Prof. Robert Sibley, University of California, section 2, "Electricity in the Crafts and Industry"; Irving E. Moultrop, chief engineer, Edison Electric Illuminating Co., Boston, section 7, "Construction and Operation of Large Power Plants"; J. P. Jackson, New York Edison Co., section 3, "Three Dimensional Load Models and Current Tariffs"; W. S. Monroe, president, Sargent & Lundy, consulting engineers, of Chicago, section 17, "Co-operation of Power-Producing Plants"; Prof. A. E. Kennelly, Harvard Engineering School, section 19, "Switchgear, Including Automatic Control Apparatus for Power Stations and Remote Metering and Signaling Apparatus"; L. W. W. Morrow, editor, *Electrical World*, New York, section 23, "World Problems of Power Supply," and Prof. Alexander G. Christie, department of mechanical engineering, Johns Hopkins University, section 34, "Education."

More than 200 engineers and industrialists will attend the conference as members of the United States party. Most of them will leave New York June 4 aboard the Hamburg-American liner "Resolute." Reservations for places in the American party will close May 15.

Damages Claimed for Death Due to Alleged Impure Water

Suit has been filed by James B. McFarland, of Ogden, Utah, against the city of Ogden, asking for damages of $20,000 for the death of his son in 1929 from typhoid fever. He alleges that death was caused by negligence on the part of Ogden in permitting impure water to be circulated in the city's system. Other suits are also pending.



SCENES AT SPRING MEETING, AM.SOC.C.E., SACRAMENTO, CALIF., LARGEST SOCIETY GATHERING EVER HELD IN THE WEST

Upper left—Boat trip on the Sacramento River enjoyed by more than 400 members and wives. Upper right—President Coleman and W. J. Ryan, of Tacoma, leaving the state Capitol, where the meetings were held. Lower left—Dedication of the monument erected by Southern Pacific employees to Theodore D. Judah, pioneer railroad engineer. Lower right—Directors Joseph Jacobs, Seattle; C. T. Morris, Columbus; and J. H. Johnston, Atlanta, with Past-President C. E. Grunsky.

Construction Progressing on Ariel 300-Ft. Arch Dam

Construction work is well under way on the Ariel hydro-electric development, being built by the Phoenix Utility Co. for the Inland Power & Light Co., located on the Lewis River in Washington about 20 miles above the mouth of the river, 10 miles above the town of Woodland, Wash., and 25 miles north of Portland, Ore. The Lewis is a tributary of the Columbia.

The principal features of the development include an arch dam, gravity dam, generating station and reservoir. The concrete arch dam will have a maximum height of 300 ft. and a top length of about 700 ft. On the north end of the arch there will be three sections of gravity dam having a total length of about 600 ft., its maximum height being 140 ft. Approximately 200 ft. of the gravity dam will be an overflow section surmounted by five tainter gates each 30 ft. deep. Four of these gates will each be 39 ft. long. The fifth one will be 10 ft. long. These gates at normal pond level will discharge 100,000 sec.-ft. The reservoir will have a usable capacity of 220,000 acre-ft. at a drawdown of 65 ft.

The generating station will be built immediately below the dam and across the bed of the river. Four steel penstocks each approximately 15½ ft. in diameter will extend from the dam to the power house, of which one only will be completely installed at this time. The generating station will have an outdoor gantry crane running over it for handling the units. The present installation will consist of one 40,000-kw. unit, but the station is being designed and built for the later installation of a second unit. Provision will be made in the generating station substructure and dam layout for two additional future units. The maximum head will be 185 ft.; the minimum at lowest drawdown of the reservoir, 120 ft.

Approximately 300,000 cu.yd. of concrete will be required for the dam, spillway channel and generating station. Active work was started on this project in November, 1929. It is expected that the plant will be ready for initial operation early in the fall of 1931.

The Ariel development will be tied in with the transmission system of the Northwestern Electric Co. through a new switching station to be erected for the latter company and which will be located near the generating station.

SITE OF ARIEL HYDRO-ELECTRIC DEVELOPMENT ON LEWIS RIVER, WASHINGTON

View shows construction progress March 1, 1930.

Headgates Nailed Up by State Engineer

Because some ranchers would not comply with the agreement on the amount of water to be taken from the Arkansas River between Salida and Leadville, Colo., M. C. Hinderlider, state engineer of Colorado, has ordered ten headgates in that zone nailed closed. Under the agreement, the ranchers must install measuring devices so that others below them may get their share of the needed water. Many refused to install the registers.

General Contractors Stabilize Association Finances

Special Board Meeting Shows Improved Finances and Higher Qualifications for Membership—Progress in Stabilizing Credits Reported

THE first meeting of the Associated General Contractors since the affairs of the organization were placed in the hands of a president's cabinet with the full powers of a general manager for one year was held at Washington, D. C., on April 28, 29 and 30. Reports were made by the cabinet and by committees having charge of various phases of the association's work in the last three months. These are summarized briefly as follows:

Association Finances Stabilized

At the present time it is not possible to state accurately what the association's receipts will total for 1930, but the estimate is about $132,000. Expenditures for the year under the present program will total about $134,500, which is made up of about $11,000 for payment on old obligations and $123,500 for operating expenses. In other words, a deficit of about $2,500 is indicated, which it is expected will be wiped out by further income.

Considering *The Constructor* and the association combined, the payroll for 1930 has been reduced about $42,000, representing elimination of the salaries of Mr. Garber, Mr. Sawyer and Mr. Embrey. The last named is now on the payroll of the Mixer Manufacturers Bureau. One field man has been taken on and a chief clerk or a staff secretary is to be added, which will make the net reduction of payroll for the year about $33,000.

This reduction of expenditures has meant curtailment of the national work and has placed a serious overload on the remainder of the staff. It represents a desperate effort to place the finances of the association on a sound basis; but is cannot continue for any great length of time without endangering the prestige and accomplishments of the organization. Under the present income there cannot be any substantial addition to the staff during 1930.

In all probability it will be the latter part of 1931, when the new scale of dues has been in effect for some months, before the national staff can be restored to a normal condition. Only through the action taken at New Orleans and through voluntary contributions has a catastrophe to the association been averted.

Membership Tightened Up

The total membership of the organization on Jan. 1, 1930, was 2,237. Since then 300 have resigned or been expelled and 184 have been added, making the present membership 2,121. Reports from the individual chapters indicate a decided tendency among practically all of them to tighten up on membership standards and to work for quality rather than quantity. Hence the loss of members here indicated may be regarded as a favorable sign and not as a loss of ground. In spite of the adverse business conditions, the membership is probably on a sounder basis than ever before.

The staff has continued its promotion

of local credit bureaus, addressing local groups as frequently as possible and working jointly with the National Building Supply Dealers Association. In some places the dealers are ready to go ahead with a program but have not secured the support of contractors. In other localities the reverse is true. The two associations are supplementing each other's efforts in a number of cities.

Credit Plans for Construction

The plan for credit control in highway and other engineering work developed by Mr. Parrish in Illinois and adopted in that state is receiving a great amount of attention. He has presented the plan before the highway chapters of Texas and New York, both of which have started work on its installation.

It is apparent that great confusion exists with respect to credit control activities, and at the present time there is need for some clear thinking. The highway contractors dealing directly with producers have a problem distinct from that of the builders located in cities and will require co-operation with altogether different agencies. In this field, contact with the crushed stone, sand and gravel associations is an important step, just as co-operation with the dealer groups is essential in the building field. The Illinois plan is commended to all highway chapters for study and installation.

Bureau of Contract

Development of the bureau of contract information is proceeding steadily and the bureau is making its influence felt in the construction world. Voluntary service records have been received from more than 2,500 construction companies and the first list showing those that have submitted their records has been issued. In a number of cases the bureau has been called upon to investigate conditions attending the writing of surety bonds and is beginning to make its usefulness felt in that field. This branch of its activity will have to proceed slowly, however, for the present. The success of the bureau seems assured and its development is proceeding rapidly.

Allied Construction Industries Committee

The allied construction industries committee, representing the contracting groups of the building industry, recently completed its fair practice recommendations for use of any of the industries desiring to make declarations of fair practice before the Federal Trade Commission. The committee's report is the first joint national declaration on the subject, and is the initial step in establishing a conception of what constitutes fair play in the industry. The subtrades represented on the conference are arranging to give these practices wide distribution.

Miscellaneous Proceedings

Addresses were delivered during the meeting by Major-Gen. Lytle Brown, Chief of Engineers, U.S.A., and by Thomas H. MacDonald, chief, Bureau of Public Roads. It was voted to hold the next annual convention in San Francisco. Since the convention in New Orleans numerous conferences have been held with General Brown, concerning the award of contracts, day labor operations and revision of specifications. He has asked that the association give him a report containing its analysis of specifications now in use and has also arranged for the submission of suggestions by contractors directly to the Mississippi River Commission. He has expressed a determination to perform the work of the corps by contact wherever possible and he has advised that where bids were called for the contract would be awarded, if the low bidder were within 25 per cent of the engineer's estimate and the contractor was responsible.

Canadian Steel Fabricators Form New Association

Steel fabricators belonging to the Canadian Manufacturers Association met in Toronto on May 2 and formed the Canadian Institute of Steel Construction, to be composed of companies engaged in construction of steel bridges and buildings. The institute will work in conjunction with the American Institute of Steel Construction and with the Canadian Manufacturers Association to establish a consulting service for architects, engineers and building owners. An effort will be made to supply technical advice on the use of steel for construction purposes. The following officers were elected: W. B. Champ, Hamilton Bridge Co., president; A. Ross Robertson, Dominion Bridge Co., Toronto, vice-president; J. M. McIntosh, Canadian Manufacturers Asosciation, secretary-treasurer, Ralph C. Manning, formerly of James & Laughlin, will be the district engineer of the organization. Offices will be located at 710-11 Bank of Hamilton Building, Toronto.

The Business Outlook

Railroad steel demand is weakening and automotive requirements show no pronounced strength. Line pipe, structural steel and farm equipment demand are still outstanding features. Structural steel awards last week, at 42,000 tons, were largest since early in February. Electric power production, rising slightly for the latest week, is still running only a little above last year's levels. The price situation has been increasingly irregular and shows further weakness. The Fisher all-commodity index, as well as the National Fertilizer Association index, declined for the week.

—The Business Week, May 7.

Conviction of Queens Engineer Upheld on Appeal

The conviction of Frederick B. Seeley, chief engineer, and Maurice E. Connolly, president of the Borough of Queens, New York City, of conspiracy to defraud the city in connection with sewer construction was upheld by the state Court of Appeals of New York on May 6. Both will be required to serve sentences of one year in prison and to pay fines of $500, the maximum sentence for the offense. The two men were convicted Oct. 17, 1928, in the Supreme Court in Long Island City. The case was immediately appealed to the Appellate Division, where the conviction was upheld by a vote of three to two, with permission to the defendants to take an appeal to the Court of Appeals, the highest court in the state. This court now unanimously upholds the conviction.

A $10,000,000 damage action instituted by the city of New York in an effort to get back some of the money expended on construction work is now pending against Connelly, Seeley and certain of the contractors concerned.

Span of Burrard Inlet Bridge Carried Away by Freighter

Again the bridge across the Second Narrows of Burrard Inlet at Vancouver, B. C., was wrecked when the south approach span was knocked from its support on April 24 by the S.S. "Losmar." The ship was caught by an unexpected turn of the tide and swung from its intended course through the open bascule span into the 150-ft. approach span. The accident interrupted vehicular and railroad service furnished by this bridge to the industrial and residential territory to the north. It is estimated that about 30 days will be required for reconstruction work, which is now under way.

This bridge was completed in 1925 and has been the scene of many shipping accidents. A tidal current reaching a speed of 7 knots per hour and a channel width between piers of only 160 ft. have combined to produce a hazard to navigation. A list of eighteen accidents occurring between 1925 and 1928 appeared in *Engineering News-Record*, Sept. 27, 1928, p. 468.

Vancouver to Get More Power

The British Columbia Electric Railway Co. is now commencing the final stage of a program of expansion at its Jordon River plant on Vancouver Island, which has been under way since 1925. This, when completed, will bring the total power development up to 37,600 hp. The fourth unit to be installed this year will add 18,000 hp. Provision was made in the original power house for accommodating the fourth unit. The flume reconstruction was commenced in 1925 and completed

in 1928. In 1928 and 1929 the reinforced-concrete intake structure with control gates and trash racks, and the boring of 201 ft. of 9-ft. tunnel were completed. Contracts for generator and turbine were also awarded, and these will be installed this spring and summer, work on the preliminaries having already commenced.

Contract for the installation of the large steel penstock was recently awarded to Hudson, King & Marpole, of Vancouver. The company will take delivery of the 5,000 steel pipe lengths from the Vancouver Engineering Works, Ltd., at Vancouver, and will transport the penstock lengths by scow to Jordon River, where a dock and derrick have just been completed. All work must be completed by the end of September of this year. The pipe ranges in size from 50 in. at the dam to 58 in. at the point where it enters the power house. In all, 9,250 ft. of penstock will be erected.

New Pumps Double Capacity of New Orleans Drainage System

On May 2 Mayor Walmsley threw an electric switch which started in operation the new drainage plant of New Orleans, La., which more than doubles the present capacity of the drainage system and will handle a uniform rainfall of 14 in. in 24 hours. The new plant includes pumping station No. 1, with three new pumps of a capacity of 1,000 sec.-ft., serving the 5,300 acres of the Broadmoor section; the Metairie relief canal, connecting stations 1 and 6, the capacity of which is raised from 2,200 to 6,000 sec.-ft.; and pumping station No. 6, at the Seventeenth St. Canal in Metairie Ridge, which will handle all of the overflow from uptown New Orleans' 11,000 acres. This station's capacity has been increased from 2,800 to 6,500 sec.-ft.

Southern Natural Gas Systems to Be Extended

The Southern Natural Gas Corp. announces an expenditure of $15,000,000 to be made immediately for the extension of its natural gas pipe line systems in Georgia, Alabama and Mississippi. Additional communities to be served with natural gas in Georgia are Macon, Griffin and Milledgeville.

Extension of the natural gas lines which now serve Atlanta and adjacent territory from the Louisiana fields will be undertaken in the immediate future, according to J. H. White, president of the corporation, and work is to be completed by Oct. 1.

Completion of the project will give the Southern and its associated companies a total system exceeding 1,700 miles, which will serve an estimated population of 1,300,000. Of the total of $15,000,000 to be expended in the extension, Mississippi will receive $7,500,000, Alabama approximately $4,500,000, and Georgia $3,000,000.

Personal Notes

J. WALTER ACKERMAN, former city manager of Watertown, N. Y., will undertake special work for the Community Water Service Co. beginning May 12.

PAGE GOLSAN, recently vice-president of the Great Western Portland Cement Co., of Kansas City, has been appointed manager of the new-business department of the engineering organization of Ford, Bacon & Davis, Inc., of New York City. His activities will cover the field of natural gas pipe line construction, industrial appraisals and management.

C. E. SWAIN, of the U. S. Bureau of Public Roads, who has been in charge of district 8, Montgomery, Ala., has been named engineer of district 6, with headquarters in Fort Worth, Tex. He succeeds A. R. Losh, who resigned last September to become state highway engineer of Oklahoma.

DAVID C. COYLE, long engaged in design of high city buildings through the firm of Gunvald Aus Co. in New York City, has established himself as consulting engineer in New York City.

R. C. FERGUS, of West Palm Beach, and HENRY WILSON, of Lakeland, Fla., divisional engineers of the Florida State Highway Department, have resigned.

QUINLAN, CODE & HILL and LEEDS & BARNARD, of Los Angeles, Calif., announce that these two engineering concerns were consolidated on May 1 to carry on jointly a broader practice of engineering than has been separately possible.

IRVING C. BROWER, city manager of Lima, Ohio, has resigned to accept a position as city manager of Greensboro, N. C.

PAUL B. SUTTON, city engineer of Watertown, N. Y., for the past ten years, has been made city manager. Mr. Sutton succeeds J. Walter Ackerman, city manager for the past seven years, who was removed from office by the city council on April 15, as noted in *Engineering News-Record*, April 14, p. 703.

Society Calendar

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; annual meeting, Atlantic City, N. J., June 23-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; annual convention, Cleveland, Ohio, July 9-11.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

INTERNATIONAL CONGRESS OF BUILDING AND PUBLIC WORKS, London; fifth congress, London, England, May 26-30.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston; annual meeting, Atlantic City, N. J., May 12-15.

NATIONAL SAFETY CONGRESS, Chicago; annual meeting, Pittsburgh, Pa., Sept. 29-Oct. 3.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, Pittsburgh, Pa.; 38th annual meeting, Montreal, Canada, June 26-28.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

DETROIT ENGINEERING SOCIETY, at its 36th annual banquet on April 25, installed the following officers: Edward M. Walker, president; Arthur S. Douglass, vice-president; Frank O. Clements, second vice-president; Paul W. Thompson, secretary-treasurer.

MARYLAND-DELAWARE WATER AND SEWERAGE ASSOCIATION will hold its fourth annual conference May 13-14 at Hagerstown, Md.

MID-SOUTH SECTION, American Society of Civil Engineers, will hold its annual meeting May 15 and 16 at Little Rock, Ark. L. L. Hidinger, Memphis, is president and R. E. Warden secretary-treasurer.

MOHAWK VALLEY ENGINEERS CLUB will meet in Utica, N. Y., on May 14, when the annual election of officers will take place and it will be decided if the club will remain in the American Engineering Council. R. M. Harrigan, Du Pont de Nemours & Co., Wilmington, Del., will speak on "Hydro-Electric Power in the New South."

NATIONAL SAND AND GRAVEL ASSOCIATION board of directors will meet May 14-15 at Milwaukee, Wis., to select the city in which the 1931 annual convention will be held and to make arrangements for a trade practice conference to be held in connection therewith. The subject of uniform cost accounting will also be taken up.

NEW YORK SECTION, American Water Works Association, met on April 24 in Buffalo. Papers were read by William H. Grotz, assistant engineer of the division of water, Buffalo; P. S. Wilson, superintendent of operations, Community Water Service Co., New York City; E. K. Wilson, chief engineer, Pitometer Co., New York City; Leonard S. Spire, Buffalo; Earl Devendorf, Albany; H. F. Wagner, Buffalo; N. J. Howard, Toronto, Ont., and J. W. Ackerman, Watertown.

NEW YORK STATE SEWAGE WORKS ASSOCIATION will meet May 10 in Albany. A. S. Bedell, State Department of Health, is secretary.

Obituary

ALLISON O. CASH, of Indianapolis, Ind., who was in the contracting business for more than 50 years, died recently after a long illness. He was 78 years old.

WILLIAM L. VENNARD, city engineer of Lynn, Mass., for the last twenty years, died suddenly on April 28. He was a member of the Boston Society of Civil Engineers.

FREDERICK B. DOWNING, lieutenant colonel, Corps of Engineers, and instructor of the Massachusetts National Guard at Cambridge, Mass., died on April 27. Colonel Downing was graduated from the Virginia Military Institute in 1902 and from the West Point Military Academy in 1906. His entire service was in the Corps of Engineers.

GEORGE DEEKS, a railroad contractor who built a considerable portion of the Michigan Central Railroad and the Illinois Central between Chicago and New Orleans, died on May 1 in Toronto, Canada, at the age of 72. Mr. Deeks had just finished for the Canadian government the laying of track giving Canada a rail outlet in northern Manitoba to Hudson Bay.

Construction Equipment and Materials

Material for Softening Water

A new water-softening zeolite known as Basex, especially applicable to municipal open-tank zeolite water-softener construction, has recently been introduced by the Inversand Co., Inc., Clayton, N. J. Basex is an olive-black sand which has been screened to filter sand specifications. It is manufactured from the basic greensand, otherwise known as glauconite. Among the claims made for this new material by the manufacturer are: complete regeneration in a zeolite water softener in 30 to 40 minutes, high base exchange capacity per unit quantity of common salt used in the regeneration process, high effective size and low uniformity coefficient. These last two properties are particularly valuable to the municipal zeolite water-softener manufacturer, since they permit high rates of flow during softening, with minimum pressure losses. It is further claimed that Basex is manufactured extremely hard and durable, thus insuring a minimum deterioration after years of continuous operation.

Basex is furnished in 150-lb. bags. It has an effective size of 0.36 mm. and a dry weight of 93 lb. per cubic foot.

Crawler Wheels for Wagons

Four sizes of crawler wheel units for attachment to almost all makes of wagons are now being manufactured by the Trackson Co., Milwaukee, Wis., to carry loads of 6, 10, 15 and 20 tons. Component parts are made of heavy alloy steel castings and drop forgings, proportioned to provide a wide margin of safety over the rated capacity. A distinctive feature is the simple and accessible take-up device which provides for adjusting the track tension under different operating conditions by varying the distance between wheel centers. Split-type hardened steel bushings are used in the shoe hinges. These are fastened into place and keyed to prevent turning, but are easily removable or reversible when worn. The tension members or links which hold the shoes in rigid position while on the ground are made of extra-heavy drop forgings, heat treated, and are so designed that they function simply by moving to and fro within one another without any turning or grinding action. Small parts, such as bolts or toggling, are entirely eliminated.

WAGON EQUIPPED WITH WIDE TREAD CRAWLERS

Instrument Combines Features of Level and Transit

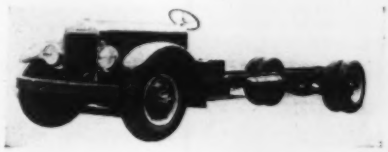
Designed especially for the control of streets, water-works and other construction and for leveling in broken ground with gradients below 10 per cent, a new lightweight instrument known as a leveling tacheometer has been developed by Kern & Co., S. A., of Aarau, Switzerland, represented in the United States by the Kern Co., New York City. The telescope, of the internal focusing type, is moisture-proof and dustproof, and is cast in one piece with the level vial housing. A folding mirror enables the operator to check the position of the bubble from the eyepiece end of the telescope. The telescope and level are so mounted that they may be tilted by means of a micrometer screw graduated to read gradients to an accuracy of 0.0001 of the distance, equivalent to $\frac{1}{8}$ in. per 100 ft. One-tenth of this fraction can still be estimated. Gradients may be read within a limit of 10 per cent up or down, equivalent to a slope of 5 deg. 43 min. Horizontal angles can be read by means of a vernier and magnifier to an accuracy of 1 min. A slow-motion screw is provided for accurate adjustment.

LEVELING TACHEOMETER

The telescope, in addition to the standard crosswires, carries short stadia lines for determining horizontal distances. The multiplication constant is exactly 100 and the addition constant is zero, so that readings can be taken directly, and by means of the vertical gradient screw, the reduced distances can be obtained directly without calculation. Tripods are available either with stiff-legs or with telescoping legs. A round level built into the base of the instrument aids in making a rapid set-up.

Low Frame Features 5-Ton Truck

Savings due to easier loading are made possible by the low frame height of the new 5-ton series 100 truck announced by Relay Motors Corp., Lima, Ohio. An improved rear axle construction, with the housing and spring pads located below the wheel center, is used in connection with the special Relay type of rear axle, of the double-reduction oscillating type in which the weight of body and load is used to aid in traction. This construction gives a distance of only 28½ in. from the top of the loaded frame to the ground, without the customary kick-up in the rear of the frame.

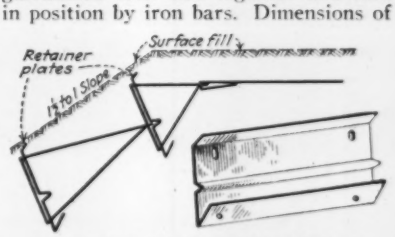


5-TON TRUCK CHASSIS

Power is provided by a six-cylinder valve-in-head motor, 4⅛x4¼ in., developing more than 100 hp. Specifications include seven-bearing crankshaft, force feed oiling system, and automatic float feed type carburetor. The clutch is of the multiple disk type; the transmission contains five speeds forward and two reverse. Equipment includes Westinghouse internal expanding air brakes operating on all four wheels, and 24-in. base balloon tires.

Device Prevents Slides on Road and Railway Fills

Acting upon the principle that slides start at the top of embankments, the W. L. Cox Manufacturing Co., Chillicothe, Mo., has developed a device consisting of a series of plates and rods which, when embedded in the upper edge of the fill, binds the material into place, preventing the formation of gulleys and slides. The fill retainer is constructed in units, consisting of retainer plates of galvanized steel tied together and held in position by iron bars. Dimensions of



FILL RETAINER INSTALLATION AND DETAIL OF STEEL PLATE

the parts and the number of tiers used depend upon conditions at the site, such as degree of slope and characteristics of the soil. Units may be put into place during construction or may be installed in existing embankments without interrupting traffic. In the former case the top connecting bar may be embedded in the concrete pavement, if desired.

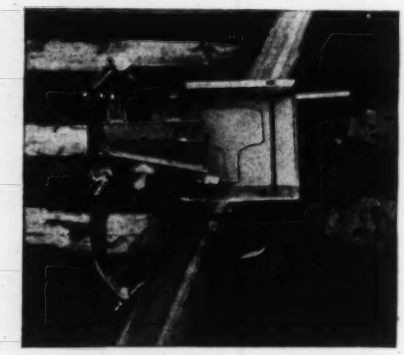
Current Surges Reduced in Single-Operator Welders

An entirely new principle which makes it easier for the operator to strike and maintain an arc under all operating conditions and which eliminates explosive arc characteristics is now being incorporated in single-operator arc welders of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The machines employing this new principle are known as Flex-Arc welders. The improvement in welding machine characteristics is obtained by the use of a special piece of apparatus, known as a Flexactor, replacing the reactor formerly used and differing from it in principle of operation.

Although the volt-ampere curve of a welding generator indicates a certain current for a given voltage, it is well known that such a current is not obtained at all times. In striking the arc, the current exceeds the steady value shown on the curve, causing sticking of the electrode. Furthermore, any lengthening of the arc causes the current to drop momentarily below the normal steady value, tending to interrupt the arc, all of which is corrected by the Flexactor. In the arc-welding process, momentary short circuits are caused by globules of metal passing across the arc. Such short circuits result in current surges and arc explosions just as in striking the arc. This explosive action, also, is eliminated. It is claimed that the effect of the Flexactor in reducing current surges is equivalent to the effect obtained with six or eight ordinary reactors, and that its ohmic resistance is not materially greater than that of one reactor.

Accurate Track Contours Taken by New Machine

Wear on railway tracks can easily be determined at suitable intervals by means of the new rail contour machine produced by the Bethlehem Steel Co., Bethlehem, Pa. This consists of a pencil tracing apparatus which is fastened directly to the rail by means of spring hooks. Movement of three scribing points along the rail surfaces is transmitted by suitable mechanism to the pencil, which produces an outline tracing of the rail to exact dimensions. Although a separate scribing point is used for the top and for each side of the rail, the resulting outline is continuous. The machine, which weighs 8 lb., is packed in a black leather case with handle and shoulder straps, which also contains accessories, such as small tools,



MACHINE REPRODUCES RAIL PROFILE

extra scribing points, pencil leads, cards and a putty knife for removing dirt and rust from the rail so that heat numbers and other markings can be read. A templet for checking the adjustment of the machine is also included.

New Publications

Lights—Portable carbide lights and lanterns are described in an 18-p. illustrated bulletin issued by the NATIONAL CARBIDE SALES CORP., New York City.

Tractors—Specifications and uses of the United crawler tractor are given an 8-p. circular issued by the UNITED TRACTOR & EQUIPMENT CORP., Milwaukee, Wis.

Pulverizing Mills—Economic and mechanical advantages of the Fuller Lehigh mills, both of the air and screen separation type, are given in a new 4-p. circular issued by the FULLER LEHIGH CO., Fullerton, Pa.

Road Machinery—A new and complete 56-p. catalog describing all products of the J. D. ADAMS CO., Indianapolis, Ind., has been issued by that company.

Motor Truck Cost Records—An analysis of the cost elements of motor truck operation, together with charts, showing the average cost of haulage under different conditions, records from the experience of large trucking companies and a series of forms used in cost keeping are included in an interesting book, "Trucking Costs—How to Lower Them," by L. A. Graham, vice-president of RELAY MOTORS CORP., Lima, Ohio, now being distributed by this company. Text matter is extremely simple, most of the information being presented in the form of graphs, illustrations and actual records.

Iron Pipe—The use of Armco ingot iron in the form of plates of light, medium and heavy gage for water supply and other engineering projects is discussed in a 20-p. illustrated booklet recently issued by the AMERICAN ROLLING MILL CO., Middletown, Ohio.

Metal Lath—A complete handbook of metal lath and accessories, containing specifications and technical data following the standard practice of lathing and plastering associations and the standard specifications of both the Associated Metal Lath Manufacturers and the American Specifications Institute, has been published by the GENFIRE STEEL CO., Youngstown, Ohio.

Highway Equipment—GENERAL WHEELBARROW CO., Cleveland, Ohio, has issued a folder briefly describing equipment for highway maintenance, including the Planetainer, rotary scraper, road drag, backfiller, plows and scrapers.

Pumps—Pump Guide No. 12, issued by the CHICAGO PUMP CO., Chicago, Ill., contains 48 pages of data to aid in the selection of pumps for different services. A number of miscellaneous tables giving useful information on pump design are included.

Electric Motors—Reliance induction motors with ball bearings for two- and three-phase alternating-current circuits are described in bulletin 106, issued by the RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio.

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
May 1,	**1930**	**205.86**	**April,**	**1930**	**351**
Apr. 1,	1930	207.12	March,	1930	408
May 1,	1929	205.15	April,	1929	332
Average,	1929	207.02	Average,	1929	317
Average,	1928	206.78	Average,	1928	287
1913		100.00	1913		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of May 8, with some comparisons, total as follows:

(In Thousands of Dollars)

	May 8, 1930	Average Preceding Four Weeks 1930	1929
Buildings:			
Industrial	$10,806	$5,590	$7,054
Other	26,970	42,856	35,994
Streets and roads.	17,161	14,833	14,035
Other eng. constr..	14,154	17,677	14,546
Total	$69,091	$80,957	$71,630
Total, all classes, Jan. 1 to May 8:			
1930			$1,294,262
1929			1,608,481

Business Notes

H. E. SALZBERG CO., INC., New York City, has purchased the Auburn & Syracuse Railroad in New York.

C. F. PEASE CO., Chicago, Ill., has appointed C. D. McCormick advertising manager to succeed W. Earle Pashley, now second vice-president and assistant sales manager. Mr. McCormick was formerly assistant advertising manager.

TRANSIT MIXERS, INC., San Francisco, Calif., has appointed Francis H. James chief engineer with headquarters at San Francisco. Mr. James was formerly connected with the Northwest Engineering Co. as sales engineer for the State of California.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio, announces that E. A. Clark, sales engineer at its Philadelphia office, has been advanced to the engineering department in Cleveland. J. C. Davis, purchasing agent for the company, was recently elected president of the Purchasing Agents Association of Cleveland.

H. D. CONKEY & CO., Mendota, Ill., has changed the name of its manufacturing division to the Conco Crane & Engineering Works division of H. D. Conkey & Co.

CUTLER-HAMMER, INC., Milwaukee, Wis., has purchased the Union Electric Manufacturing Co., also of Milwaukee, which has specialized in drum-type control apparatus. The present factory of the Union company will be operated as the manufacturing division of Cutler-Hammer, and branch sales offices and warehouse stocks will be consolidated immediately. E. F. Le Noir, president of Union, will become a member of the headquarters sales staff of Cutler-Hammer. Most of the Union personnel, particularly the sales and engineering departments, will also join the Cutler-Hammer organization.

JEFFREY MANUFACTURING CO., Columbus, Ohio, has elected Robert W. Gillispie president and general manager of the company. He was formerly vice-president and general manager. At the same time the board elected Robert H. Jeffrey, former president, to the position of chairman of the board. Mr. Gillispie is also president of two subsidiary companies, the Jeffrey Manufacturing Co., Ltd., Montreal, Canada, and the Galion Iron Works & Manufacturing Co., Galion, Ohio.

CHRIS D. SCHRAMM, founder and former president of Schramm, Inc., West Chester, Pa., died on April 9 at the age of 77. Mr. Schramm came to this country from Germany in 1881, and was for 30 years a manufacturer of machinery. Until four years ago he was president of Schramm, Inc.

Unit Prices From Current Construction Bids

Rock Tunnels 40,642 Ft. Long for Owyhee Project in Oregon-Idaho

TWO concrete-lined water tunnels totaling 40,642 ft. in length will form a part of the distribution system of the Owyhee (federal) irrigation project of 125,000 acres in Oregon and Idaho, being constructed under direction of the Bureau of Reclamation.

The tunnel work is located near Nyssa, Ore., and the proposal was set out in nine schedules, of which 1 to 4 combined were alternative to schedules 5 to 8 (accepted). The latter are for tunnels 1 and 5 instead of 1 and 2 (Fig. 1). The schedules, which include some roads and structures in addition to tunnel work are:

1. Upper portion tunnel 1, 14-ft. dia. stations 0 + 50 to 93 + 50, and road to tunnel inlet.
2. Lower portion of above, stations 93 + 50 to 188 + 20, and Tunnel Canyon Road.
3. Upper portion tunnel 2, stations 0 + 25 to 166 + 00, and road from tunnel 1 to tunnel 2.
4. Lower portion of above, stations 166 + 00 to 348 + 00.
5. Upper portion tunnel 1, 16-ft. 7-in. dia., stations 0 + 50 to 93 + 50, and road to inlet of tunnel 1.
6. Lower portion of above, stations 93 + 50 to 188 + 20, and Tunnel Canyon Road.
7. Upper portion tunnel 5, stations 1 + 60 to 112 + 00.
8. Lower portion of above, stations 112 + 00 to 222 + 60.
9. West side road to top of dam.

Bids were asked, therefore, on a 14-ft. tunnel 18,722 ft. long and a 9-ft. 4-in. tunnel 33,307 ft. long, *or* on a 16-ft. 7-in. tunnel 18,722 ft. long and a 9-ft. 3-in. tunnel 21,920 ft. long. The principal items and the maximum estimated quantities were as follows: 280,000 cu.yd. of all classes of tunnel excavation: 114,000 cu.yd. of all classes of excavation other than tunnel; 23,000 sta. cu.yd. of overhaul; 74,000 cu.yd. concrete in tunnel lining; 1,600 cu.ft. of pressure grouting; laying 600 lin.ft. of 12- and 18-in. corrugated metal pipe; constructing 53,000 lin.ft. of tunnel and outlet closed drains; furnishing and erecting 330,000 ft. timbering in tunnels; and furnishing and erecting 209,000 lb. structural steel in tunnels.

Material Furnished—The government will furnish cement and admixtures, pipe and fittings for drains, corrugated pipe and coupling bands for culverts, and all other materials that will become a part of the completed construction. These will be delivered to the contractor f.o.b. cars at Dunaway Siding, Ore., for schedules 1, 2, 3, 5, 6, 7 and 9, and for schedules 4 and 8, f.o.b. cars at railway station on the Homedale branch of the Oregon Short Line Railroad most convenient to the work. The contractor furnishes all sand and gravel for concrete, sand for grout, gravel or broken rock for backfill around drainpipe, rock for paving the west side road, all backfill materials, all materials for temporary and permanent tunnel timbering, tar paper over tunnel drains, water for mixing and cleaning, and all other materials that will not become a part of the completed construction.

The contractor assumes full responsibility for estimating the nature of the rock or materials to be excavated. Some assistance in this is afforded by two reports on the geology of the country in the vicinity of the tunnels. Copies of these reports were on file at the offices of the Bureau of Reclamation at Owyhee dam and Denver, but the government assumes no responsibility for conclusions in these reports.

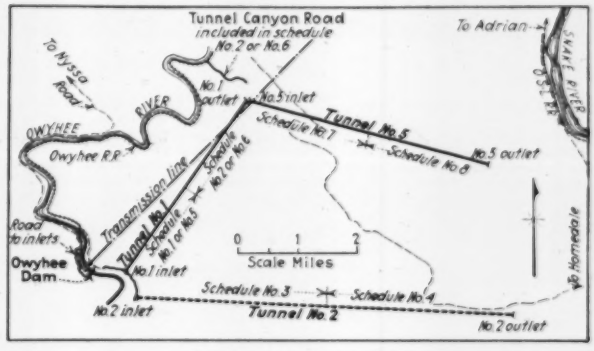


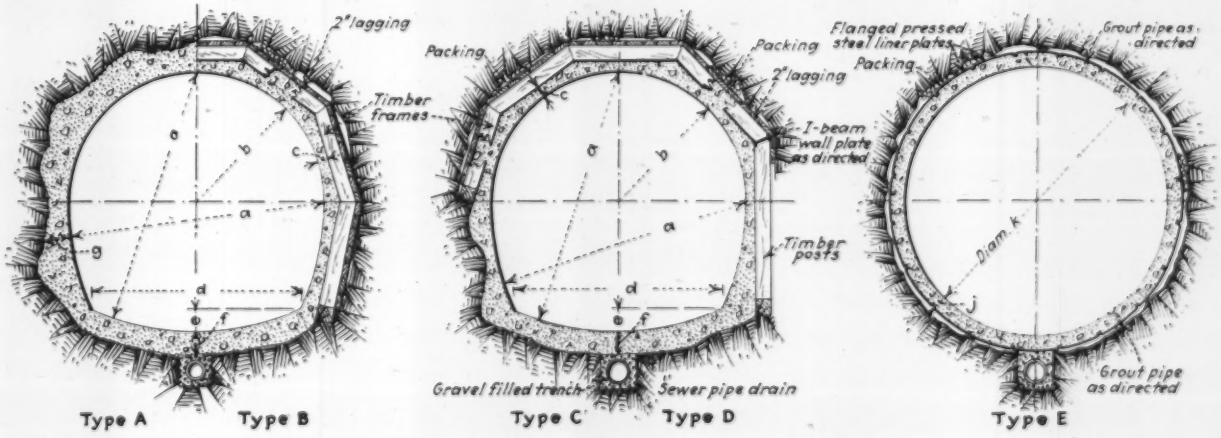
FIG. 1—LOCATION MAP

Electric power is furnished by the government, and the contractor was asked to estimate the horsepower he would need for each schedule.

The Owyhee Railroad from Dunaway Siding on the Oregon Short Line to Owyhee is owned by the government and is being operated by the General Construction Co., which is building the dam for the project (contract awarded last summer). This company has constructed a road from the north end of the railroad bridge near Owyhee to a point near the east end of the cableway track at the Owyhee dam site. The contractor for the upper portion of tunnel 1 may use this road upon payment of $2,500 to the General Construction Co., and he must maintain this road and construct and maintain a road from the east end of it to tunnel 1 inlet. The Tunnel Canyon Road, connecting the railroad and tunnel 1 outlet and tunnel 5 inlet, is maintained by the contractor on the lower portion of tunnel 1 during the period of his contract, and thereafter by the contractor for the upper portion of tunnel 5.

Sand and Gravel—Sand and gravel pits are available in the vicinity of Dunaway where the Owyhee Railroad connects with the Oregon Short Line. These pits belong to the government and an adequate section will be turned over to the contractors without charge.

Excavation—Prices are furnished for three classes of excavation as follows: (1) material that can be ploughed 6 in. deep by six horses handled by four men; loose material handled with team-drawn scrapers; material not requiring blasting and that can be handled by power shovels or draglines; (3) solid rock removed by blasting, and boulders more than ½ cu.yd.; (2) mate-



Dimensions	a	b	c	d	e	f	g	h	j	k
Tunnel No. 1	16'-7"	8'-3½"	8" min.	13'-7½"	1.47'	16"	8" min. 15" av'g.	15" av'g.	12"	17'
Tunnel No. 5	9'-3"	4'-7½"	6" min.	7'-7½"	9⅞"	10"	6" min. 10" av'g.	10" av'g.	10"	9'-6"

FIG. 2—TYPICAL TUNNEL SECTIONS

rial other than classes 1 and 3 such as hardpan, cemented gravel and soft or disintegrated rock which cannot be excavated efficiently by power shovels or draglines or by ploughs or by scrapers, and boulders of 2 cu.ft. to ½ cu.yd. Suitable material excavated in building the roads will be used for road embankment. Tunnel material in open cuts above and below portals may be wasted on government right-of-way. As far as practicable, material excavated for structures will be used for embankment and backfill.

Payment—Where permanent timbering or steel tunnel lining is not required, measurement of excavation for payment is limited to excavation required for the prescribed average thicknesses of concrete lining. For the unlined sections of tunnels and shafts, excavation is limited to the neat lines prescribed by the contracting officer. Where permanent timbering without lagging is required, excavation is to lines formed by the outer perimeter of the timber bents. Where permanent timbering with lagging is required, measurement is made to lines formed by the outer perimeter of the timber lagging. Where the steel and concrete lined circular section is used, payment is limited to the area of a circle of which the radius is 3 in. greater than the outside radius of the steel lining. Where the construction of any tunnel is included in two separate contracts, the contractor who first completes the excavation of the portion of the tunnel included in his contract may, at his option and with the consent of the government and the other contractor, continue excavating until the tunnel is holed through, but for a distance not exceeding 25 per cent of the length of the tunnel under his contract.

Timbering—Temporary timbering may be left in place if it will not weaken the concrete lining. All permanent and temporary timbering left in place is well-seasoned sound rectangular timber. The cost of furnishing and erecting temporary timbering is included in the excavation prices. There is nothing to prevent the contractor at his own expense from erecting such temporary timbering as he considers necessary or from using heavier permanent timbering than specified.

Plate Steel Lining—Steel liner plates and arch ring segmental bars are installed in portions of the tunnels to be lined with concrete. All excavated space behind the lining is solidly packed with clean washed gravel or spalls. The amount of plate-steel tunnel lining required is uncertain, and the contractor is not entitled to additional compensation above the prices bid. The contractor may use at his own expense any amount of suitable temporary supports for the roof and sides of the tunnels.

Tunnel Drains—Longitudinal sewer pipe drains are constructed between the inlet portal of each tunnel and the beginning of the transition from horseshoe or circular tunnel section to rectangular at the outlet portal. The size of drain cannot be determined until excavation has proceeded far enough on both upper and lower portions to indicate the amount of water that will be developed. In the upper portion the size of pipe will be determined as the excavation proceeds. The pipe (furnished by the government) is laid with partly open, uncemented joints. Broken rock or gravel backfill, furnished by the contractor, is placed about the pipe. Tar paper is furnished and placed by the contractor over the gravel fill to prevent the concrete of the tunnel lining from entering the gravel backfill.

Concrete Lining—Except as otherwise provided, the tunnels are lined throughout. Where permanent timbering is required, it is set back from the inside face of the lining to provide for a minimum covering of concrete over the timbers. Volume of all timbering is deducted in determining volume of concrete for payment. Where plate-steel tunnel lining is installed, measurement of concrete lining for payment is for concrete actually placed to specified thickness.

Concrete—In general the mix is 1 part (by weight) of cement to 2 parts sand and 4½ parts gravel. The principle is to obtain satisfactory concrete without using too much cement.

Bidding—Ten contractors bid on the alternate projects: schedules 1 to 4 for tunnels 1 and 2, and schedules 5 to 8 for tunnels 1 and 5, and schedule 9 for west side road to top of dam. Six of these contractors bid on all schedules, as follows:

Contractor	Schedules 1 to 4	Schedules 5 to 8	Per Cent in Favor 5 to 8
J. F. Shea Co.	$3,546,222	$3,243,963	— 9
Fisher, Ross, MacDonald & Kahn, Inc.	3,643,817	3,142,168	—14
T. E. Connolly	3,761,635	3,386,355	—10
Utah Construction Co.	3,798,295	3,286,825	—13
A. Guthrie & Co., Inc.	4,923,429	4,708,380	— 4
W. S. Mead	5,191,903	4,928,311	— 4
Average	4,144,217	3,782,667	— 9

The accompanying table gives unit prices of the lowest three bidders on each of schedules 5 to 8. Two contractors underbid B on schedule 6 and on schedule 7, but B stipulated that if awarded both schedules $64,167 should be deducted. This deduction made his 6-plus-7 total the lowest. The bidders are: (A) T. E. Connolly, San Francisco; (B) J. F. Shea Co., Portland, Ore.; (C) Fisher, Ross, MacDonald & Kahn, Inc., San Francisco; (D) Utah Construction Co., Ogden; (E) S. S. Magoffin & Co., Ltd., North Vancouver, B. C.; (F) Morrison-Knudsen Co., Boise. Contract has been awarded on the basis of the low bids:

Sch. 5 and 6, Tunnel 1, 16 ft. 7 in., 18,722 ft.		
Upper end	T. E. Connolly	$982,116.00
Lower end	J. F. Shea Co.	
Sch. 7 and 8, Tunnel 5, 9 ft. 3 in., 21,920 ft.		1,569,011.20
Upper end	J. F. Shea Co.	
Lower end	S. S. Magoffin & Co., Ltd.	530,684.00
Government differential		300,000.00
		$3,381,811.00

The $300,000 differential was provided for in the specifications for schedules 5 to 8. Under this combination of schedules the government must construct, operate and maintain other irrigation works not included in the specifications but is required to deliver water at some point near the outlet of Tunnel 1.

Three bids were received for schedule 9, as follows: $6,947, $7,916 and $13,016. Because of wide variation, the unit prices are not given here. No award will be made under this schedule, which covers the west side road and structures.

Schedule 5	A	B	C
Excavation for road, Cl. 1—1,600 cu.yd.	$0.50	$0.50	$0.40
Excavation for road, Cl. 2—9,000 cu.yd.	.70	1.00	.70
Excavation for road, Cl. 3—3,600 cu.yd.	1.40	2.00	1.25
Excavation for culverts, all classes—20 cu.yd.	2.00	1.00	2.00
Laying 18-in. corrugated metal pipe—50 lin.ft.	1.00	.50	2.00
Backfill around culverts—20 cu.yd.	1.00	.50	1.00
Excavation in open cut—2,000 cu.yd.	1.50	1.00	2.00
Excav. of tunnel, all classes—107,000 cu.yd.	6.12	6.35	7.00
Constructing 8-in. tunnel drain—4,400 lin.ft.	.30	1.20	.50
Constructing 10-in. tunnel drain—4,400 lin.ft.	.30	1.40	.60
Constructing 12-in. tunnel drain—500 lin.ft.	.40	1.60	.70
Permanent timbering in tunnel—53 M.ft.b.m.	70.00	60.00	110.00
Steel liner plates—55,000 lb.	.07	.10	.12
I-beam wall plates—4,000 lb.	.07	.10	.12
Concrete in tunnel lining—26,200 cu.yd.	11.42	10.00	8.00
Drilling grout holes—200 lin.ft.	1.00	1.00	1.50
Making grout connections—300	1.00	1.00	2.00
Pressure grouting—400 cu.yd.	1.00	1.00	2.00
Pumping excess water—1,000 mil. gal.	.10	2.00	.50
Total	$982,116	$985,725	$995,300

Schedule 6	B	A	D
Excavation for road, Cl. 1—6,300 cu.yd.	$0.50	$0.60	$0.30
Excavation for road, Cl. 2—6,700 cu.yd.	1.00	.80	.50
Excavation for road, Cl. 3—15,000 cu.yd.	2.00	1.40	1.00
Excavation for culverts all classes—10 cu.yd.	1.00	2.00	2.00
Overhaul—23,000 sta. cu.yd.	.05	.03	.02
Laying 12-in. corrugated metal pipe—200 lin.ft.	.50	1.00	.50
Backfill around culverts—95 cu.yd.	1.00	1.00	.50
Excavation in open cut. Cl. 1—500 cu.yd.	.50	.80	.40
Excavation in open cut, Cl. 2—3,800 cu.yd.	1.00	1.00	.60
Excavation in open cut, Cl. 3—200 cu.yd.	2.00	1.50	1.20
Excav. of tunnel, all classes—106,900 cu.yd.	6.35	6.02	5.80
Excavation for outlet grain, Cl. 1—20 cu.yd.	1.00	1.00	.60
Excavation for outler drain, Cl. 2—40 cu.yd.	2.00	1.00	1.00
Excavation for outlet drain, Cl. 3—45 cu.yd.	3.00	1.50	1.40
Constructing 8-in. tunnel drain—600 lin.ft.	1.20	.25	1.20
Constructing 10-in. tunnel drain—4,000 lin.ft.	1.40	.30	4.00
Constructing 12-in. tunnel drain—4,000 lin.ft.	1.60	.35	1.60
Constructing 15-in. tunnel drain—744 lin.ft.	1.80	.40	1.80
Laying 18-in. drain pipe—144 lin.ft.	1.00	.50	.80
Permanent timbering in tunnel—95 M.ft.b.m.	60.00	70.00	70.00
Steel liner plates—55,000 lb.	.10	.07	.10
I-beam wall plates—7,000 lb.	.10	.07	.10
Concrete in tunnel lining—27,350 cu.yd.	10.00	11.23	12.60
Drilling grout holes—200 lin.ft.	1.00	1.00	1.00
Making grout connections—300	1.00	1.00	2.50
Pressure grouting—400 cu.ft.	1.00	1.00	1.50
Total	$1,025,208	$1,001,460	$1,017,024

Schedule 7	B	C	D
Excavation in open cut—2,000 cu.yd.	$1.00	$2.00	$7.00
Excav. of tunnel, all classes—40,000 cu.yd.	10.55	10.30	10.25
Constructing 8-in. tunnel drain—3,500 lin.ft.	1.20	.50	1.20
Constructing 10-in. tunnel drain—3,500 lin.ft.	1.40	.60	1.40
Constructing 12-in. tunnel drain—3,500 lin.ft.	1.60	.70	1.60
Constructing 15-in. tunnel drain—450 lin.ft.	1.80	1.00	1.80
Permanent timbering tunnel—46 M.ft.b.m.	60.00	112.50	70.00
Steel liner plates—50,000 lb.	.10	.12	.10
Concrete in tunnel lining—11,200 cu.yd.	14.00	10.00	14.60
Drilling grout holes—200 lin.ft.	1.00	1.50	1.00
Making grout connections—300	1.00	2.00	2.50
Pressure grouting—400 cu.ft.	1.00	2.00	1.50
Pumping excess water—1,000 M gal.	2.00	.50	5.00
Total	$606,970	$548,125	$605,800

Schedule 8	F	C	F
Excavation in open cut—3,000 cu.yd.	$2.00	$2.00	$3.00
Excav. of tunnel, all classes—40,600 cu.yd.	9.50	10.30	9.75
Excavation for outlet drain—50 cu.yd.	3.00	2.50	2.00
Constructing 8-in. tunnel drain—200 lin.ft.	.75	.50	.50
Constructing 10-in. tunnel drain—5,000 lin.ft.	1.00	.60	.75
Constructing 12-in. tunnel drain—5,000 lin.ft.	1.50	.70	.75
Constructing 15-in. tunnel drain—400 lin.ft.	2.00	1.00	1.00
Constructing 18-in. tunnel drain—340 lin.ft.	3.00	1.00	1.50
Laying 18-in. drain pipe—120 lin.ft.	2.00	1.00	1.00
Backfill around pipe—40 cu.yd.	1.00	1.00	1.00
Permanent timbering in tunnel—160 M.ft.b.m.	20.00	112.50	70.00
Steel liner plates—50,000 lb.	.06	.12	.08
Concrete in tunnel lining—11,600 cu.yd.	9.99	10.00	14.00
Drilling grout holes—200 lin.ft.	2.00	1.50	1.00
Making grout connections—300	2.00	2.00	2.00
Pressure grouting—400 cu.ft.	2.50	2.00	1.00
Total	$530,684	$573,505	$592,420

Note: Deduct for 6 and 7 combined $63,167 from bid of B.